

## **Appendix D**

### **I/I Pilot Project Flow Monitoring**

*Tables follow text.*

#### **Description:**

This appendix documents: (a) the pre-rehabilitation flow monitoring conducted during the winter of 2002/2003, and (b) the post-rehabilitation flow monitoring conducted during the winter of 2003/2004 for the I/I pilot project basins.

#### **Reference Chapter:**

Chapter 8 – Rehabilitation Effectiveness

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See also:

- *2000/2001 Wet Weather Flow Monitoring, May 2001*
- *2001/2002 Wet Weather Flow Monitoring, June 2002*



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## Section 1 - Equipment Summary

Three types of open-channel flow meters from Marsh-McBirney, Inc. and ADS Environmental Services (ADS) were installed and used during the 2002/2003 (pre-rehabilitation) and 2003/2004 (post-rehabilitation) monitoring periods. The flow meter technology of each type of meter used during the pre- and post-rehabilitation periods is summarized below based on information gathered from the manufacturer (or vendor) of the respective meter type. Detailed information on meter specifications and/or accuracy is tabulated in Table D-1.

### 1.1 ADS Environmental Services Model 3600/01 Flow Meter

The ADS 3600/01 flow monitoring system uses a combination of depth and velocity sensors and a data logger (monitor) to measure flow.

Depth is measured using an ultrasonic sensor and a pressure sensor. The ultrasonic sensor is mounted at the crown of the pipe and consists of four separate transceiver crystals, with each crystal capable of transmitting and receiving ultrasonic signal. It calculates the depth of flow by transmitting and receiving sound waves from the top of the pipe to the water surface (the range) and measuring the time elapsed between transmission and reception of the signal. This sensor only measures depth of flow (DOF) up to full pipe capacity.

The pressure sensor is often mounted at the bottom of the pipe and can measure depths of flow greater than full pipe. This sensor contains a differential pressure transducer that transmits an output voltage corresponding to the difference between the water pressure and the air pressure in the sewer pipe. The depth board in the monitor calculates the depth of flow based on the difference in pressures.

The Doppler velocity sensor has two ultrasonic crystals and is mounted at the bottom of the pipe. The transmitting crystal sends ultrasonic sound waves at a specific frequency upward into the flow. The receiving crystal then receives sound waves that have been reflected by particles in the flow. The change in the sound waves' frequency from transmission to reception is used to determine the velocity of the flow based on the Doppler effect principle. The Doppler velocity sensor measures the peak velocity that must be converted to an average velocity for flow calculation. Average velocity is calculated from the peak velocity using average-to-peak ratios ( $A_v/P_k$ ) and gain values calculated from velocity profiles performed during monitoring.

FieldScan and Profile, ADS proprietary software packages, are used to configure and activate meters, collect data, perform diagnostic procedures, and for data review/analysis.

## **1.2 Marsh-McBirney Flo-Tote Models 260 and 3000**

The Marsh-McBirney Flo-Tote models are electromagnetic area/velocity flow meters that measure both velocity and level using a single probe. Both velocity and level sensors are housed in one probe, which is installed at the bottom of the pipe. The Model 3000 (FT3) meter has a sensor that can be disconnected and a logger, which is interchangeable with the Model 460 Flo-Dar sensors. The Model 260 (FT2) meter has a system where the sensor and logger are one unit.

The open channel sensor utilizes Faraday's Law of Electromagnetic Induction to measure velocity of the water in the pipe. The sensor generates an electromagnetic field, creating a voltage in the water. The magnitude of the voltage is directly proportional to the velocity of the water. The velocity electrodes on the top of the sensor measure this voltage, which is then translated into velocity of the water. Average velocity is calculated from the sensed velocity using site calibration coefficients calculated from velocity profiles performed during monitoring.

The level or depth of water is measured using a piezo resistive differential pressure transducer located in the sensor. The transducer is an electronic device that uses a thin diaphragm to convert pressure to an electronic signal. The level is calculated using the difference between the water and air pressure (also read by the transducer) readings.

## **1.3 Marsh-McBirney Flo-Dar Models 460**

The Flo-Dar unit combines digital Doppler radar velocity sensing technology with ultrasonic pulse echo and a pressure transducer to measure open channel flow. The data from the sensors are stored in a data logger connected to the sensor. The sensor is mounted slightly above the top of the pipe being measured and can withstand being submerged during surcharged conditions.

The water velocity is determined much the same way that radar guns measure the velocity of an automobile or a baseball. The radar beam is transmitted from the sensor at a defined angle to the flow surface. The sensor measures the surface velocity of the water by determining the shift in frequencies between the transmitted and received signals (reflected from the surface). The sensed surface velocity is converted to average velocity using empirical equations or algorithms embedded in the sensor. The radar velocity sensor does not work once the sensor is submerged in the water.

A pulse echo, look-down, ultrasonic transducer in the sensor unit is used to measure the depth of flow (or level of fluid). When the fluid level rises higher than 4 inches below the ultrasonic transducer, the depth of flow is determined using the pressure transducer. Flo-Ware, a proprietary software package, is used to configure and activate meters, collect data, and to perform diagnostics and data review/analysis.

## Section 2 - Uptime Percent Summary

There were data losses during the 2002/2003 (pre-rehabilitation) and 2003/2004 (post-rehabilitation) monitoring periods. The data losses (and data gaps) ranged in duration from less than 1 day to a little over 3 weeks during the pre-rehabilitation monitoring period and from about 1 day to about 1 week during the post-rehabilitation period.

The probable reasons for the data loss are discussed in Chapter 8 and include: (a) mismatches in computer software versions between the flow meter and the computer used for data downloading, (b) low battery voltages, and (c) meter "lock up" during field verifications.

Firmware and software incompatibility can cause corrupt files that eventually lock up the meter and cause communication errors when downloading data. To "unlock" the meter, a new site set up must be sent. This process clears or deletes any data in a unit's memory. Battery-related problems include low voltages or loss of power due to loosening of the main battery contacts when the unit is pulled and laid on its side during data download. If the battery is not secured inside the compartment, the connection between the data logger and sensor is lost, resulting in no data recorded.

Some of the observed data gaps in the flow data are the result of editing out (or flagging) poor quality data from the final flow calculation.

Tables D-2.1 and D-2.2 contain tabulated information on data gap periods at specific monitoring sites and the main reasons for the observed data losses and gaps in the final flow calculation.

## Section 3 - Field Verification Procedures

As briefly discussed in Chapter 8, field verifications were performed to finalize the data and calculate flow quantity.

Field verification included manually measuring depth, velocity, and flow quantity at the monitoring site and comparing these readings with real-time readings from the meter. Field verifications were used to independently verify the accuracy of the flow meters and to generate depth-velocity relationships and variables that could be used in flow calculations (example: site coefficients for Marsh McBirney Flo-Tote meters, velocity multipliers for Flo-Dar meters, and average-to-peak ratios  $[Av/Pk]$  for ADS meters). Field crews descended into the manhole to take the manual measurements.

The type of field verification performed depended on the monitoring site conditions. A complete velocity profile was performed at sites where depth of flow was greater than 5 inches and remained relatively constant, and flow was stable. For sites with depths of flow between 2 and 5 inches, a peak velocity and depth (PVD) verification was performed. Weir verifications were performed at sites where the depth of flow was less than 2 inches. Flow quantities were verified using a volumetric weir.

A velocity profile was performed at sites where the depth of flow was greater than 5 inches. Velocity profile information allowed average velocity to be determined in order to calculate  $Av/Pk$  ratios (ADS meters), site coefficients (Flo-Tote 2 and 3), and velocity multipliers (Flo-Dar) for use in flow calculations. When performing a velocity profile, velocity readings were taken with a portable velocity meter at set depths of flow. PVD readings were performed before and after a velocity profile.

PVD verification involved taking manual field measurements and then comparing these values with meter readings taken within a few minutes of the manual readings. Once a field crew member entered the manhole, meter readings were taken by "firing" the sensors. The field measurements were then taken immediately (or within a few minutes) following the meter measurements. Once the field crew member positioned himself/herself where the flow was unobstructed, depth was measured (where the flow was deepest) to the nearest 1/8 inch. The depth could be measured in two ways. The first involved placing the measuring stick or ruler directly in the flow at the appropriate location in relation to the pipe and the sensor, and taking the readings (DOF). The second method involved placing the measuring stick (or ruler) at the face of the ultrasonic sensor (for ADS meters and Flo-Dars) or at the crown of the pipe and measuring the air gap from these locations down to the water surface (air DOF). For sites with sediment/silt accumulation, the depth of silt was measured and recorded. Once the depth measurement was taken, peak velocity was measured by scanning through the flow with a portable velocity meter. The manually measured depth and velocity results from the portable velocity meter were recorded on a site calibration form along with the sensor/meter real-time measurement.

Weir verification was performed at flows where manual velocity readings were difficult or impossible due to the shallow DOF. The THEL-MAR Volumetric weir was used to verify flow quantity at shallow depths. The THEL-MAR Volumetric weir is a compounded weir that incorporates the advantage of a 90° V-notch for measuring flow. The V-notch section measures from 57 to 3,700 gallons per day (gpd). The rectangular portion of the weir is capable of measuring (in gpd) up to 35 percent of pipe capacity. Flow rates are indexed on each side of the weir and the calibration lines are in 2-millimeter (mm) (0.0787- inch) increments.

Once the weir was installed, it was leveled using the bubble level mounted at the top of the weir plate. Flow rates were read after letting the water back up behind the weir and flow was uniform and stabilized. Instantaneous flow rates were read where the flow surface intersected the calibration lines. Manual readings of the depth of flow (DOF) and peak velocity were taken before installing the weir and after the last weir measurement was taken and the flow stabilized and returned to "normal." A set of three manual and real-time measurements were taken per site (verification) visit.

Once the field verifications were performed, the results were recorded on a site calibration/verification form. Information entered in the site calibration forms included date and time of site visit, site name and meter/sensor serial number, real-time depth and velocity readings, manual depth and velocity readings, silt level, battery level, and site conditions and observed problems.

The error margin for the manual depth measurements was set at +/- 0.13 inches. Some site conditions that could have affected field verification results include velocities greater than 7 feet per second (ft/sec), especially in shallow flow conditions; presence of a pump station upstream of a monitoring site; wavy and surging flow conditions in the monitoring location; and limited bench room and work space in the monitoring location.

Summaries of the field verifications performed during the pre- and post-rehabilitation monitoring periods are shown in Tables D-3.1, D-3.2 and D-3.3.

## Section 4 - Data Editing and Finalization Process

As briefly discussed in Chapter 8, raw data collected from the flow meters were reviewed and edited as necessary. Field verifications and site finalization procedures were performed to finalize the data and calculate flow quantity.

Field verifications were used to independently verify the accuracy of the flow meters and to generate depth-velocity relationships and variables that could be used in flow calculations.

The process of site finalization included re-measuring the pipe dimensions, measuring any silt accumulation in the pipe, reviewing any unusual hydraulic conditions at a monitoring site, and reviewing and evaluating velocity parameters including gain, average-to-peak ratios, site coefficients, and velocity multipliers. Measuring the silt level was very important because any sediment in the pipe would displace the flow (artificially raising the DOF) and skew the flow calculations.

The quality and reliability of depth and velocity readings from flow meters determined the accuracy and reliability of the resulting calculated flow quantity. Depth and velocity sensors can be affected by local hydraulic conditions at the monitoring site and can give erroneous or invalid readings. Some of the factors contributing to poor quality depth and/or velocity data can include:

- Slow and sluggish flows (2 ft/sec velocity) contributing to sensor fouling
- Downstream blockage, and possibly related upstream surcharges contributing to sensor fouling
- Shallow and fast flows where a slight increase in depth may cause the flow to spray off the sensor/ring assembly and splash onto the ultrasonic sensor (mounted at the crown of the pipe), yielding erroneous depth data
- Non-uniform and poor velocity profiles (in the pipe), resulting in erroneous calculation of average-to-peak ratios, gain values, or velocity multipliers
- Malfunctioning depth and/or velocity sensors
- Very shallow flow conditions where the sensors are unable to sense velocity during such low flow conditions (velocity is forced to zero)
- Incorrect site setups during meter installation or reactivation

Erroneous data included depth and/or velocity "pops" and "drop outs", depth and velocity not showing matching diurnal patterns during normal open channel flow, and shifts in depth indicating a backwater condition unaccompanied by a drop in velocity. Erroneous or invalid data were identified using a scattergraph (x-y plot of depth versus velocity) and hydrograph (time series plot of depth and velocity).

Editing data involved removing and/or correcting unreliable or invalid depth and velocity data. Based on review and analysis of field confirmations, field crew observations during site visits, and historical trend and data consistency with site hydraulics, some of the invalid data was reconstituted or flagged. Flagging is a term applied to removing the invalid data from flow calculations. The terms "data reconstitution," "reconstruction," or "snapping" refer to the process of generating depth-velocity relationships using good quality and valid data to reconstruct poor/erroneous velocity (and in some cases depth) data. These terms are used interchangeably in this report. Reconstituted or snapped data are used in flow quantity calculations.

#### **4.1 Using Scattergraphs and Hydrographs to Review and Edit Data**

An x-y plot was used to graph depth and velocity data from meter readings and results from field verifications. This scattergraph technique of data evaluation and reconstitution is based on a definable depth-velocity relationship and the theoretical Manning pipe curve, which predicts that in open channel gravity flows, there is a predictable velocity for every depth of flow. For a properly functioning meter, the depth and velocity readings should fall on or around the pipe curve. Depth and velocity field confirmations were plotted on the depth-velocity scattergraph and were compared to meter readings to verify that the meter was functioning properly.

Hydrographs are time series plots showing depth and velocity (and flow quantity if desired). Hydrograph plots can be used to identify and edit erroneous/invalid depth and/or velocity data.

Scattergraph and hydrograph plots can show repeatability of the measured data, provide information on the steadiness of the flow, and show significant hydraulic changes such as backwater conditions and flow increase due to rain events. Scattergraphs and hydrographs can also be used to reconstruct or snap erroneous/invalid data when supported by field confirmations and well-established depth-velocity relationships, or to flag erroneous/invalid data when there is not enough justification to reconstruct or snap the data.

The following examples show how invalid data were identified, flagged, and in some cases snapped (to curve) using hydrograph and scattergraph plots. The example below shows how changes in hydraulic conditions were identified using a combination of hydrograph and scattergraph plots.

### 4.1.1 Invalid Depth Data

Figure 4.1 illustrates how invalid depth was identified and flagged on a hydrograph. Depth and velocity showed repeated diurnal patterns with velocity increasing with an increase in depth. Around 11/25/03, depth values spiked without any significant and matching increase in velocity. There were no rain events on 11/26 and 11/27, but the depth of flow spiked to depths of flow close to that observed during the significant rain events on 11/18 and 11/19/03. Although there was a rain event on 11/28, the effect was masked by the invalid depth data before and after this rain event. The invalid data were flagged and were not used for flow quantity calculation.

**Figure 4.1- Hydrograph of Invalid Depth Data Due to Sensor Fouling**

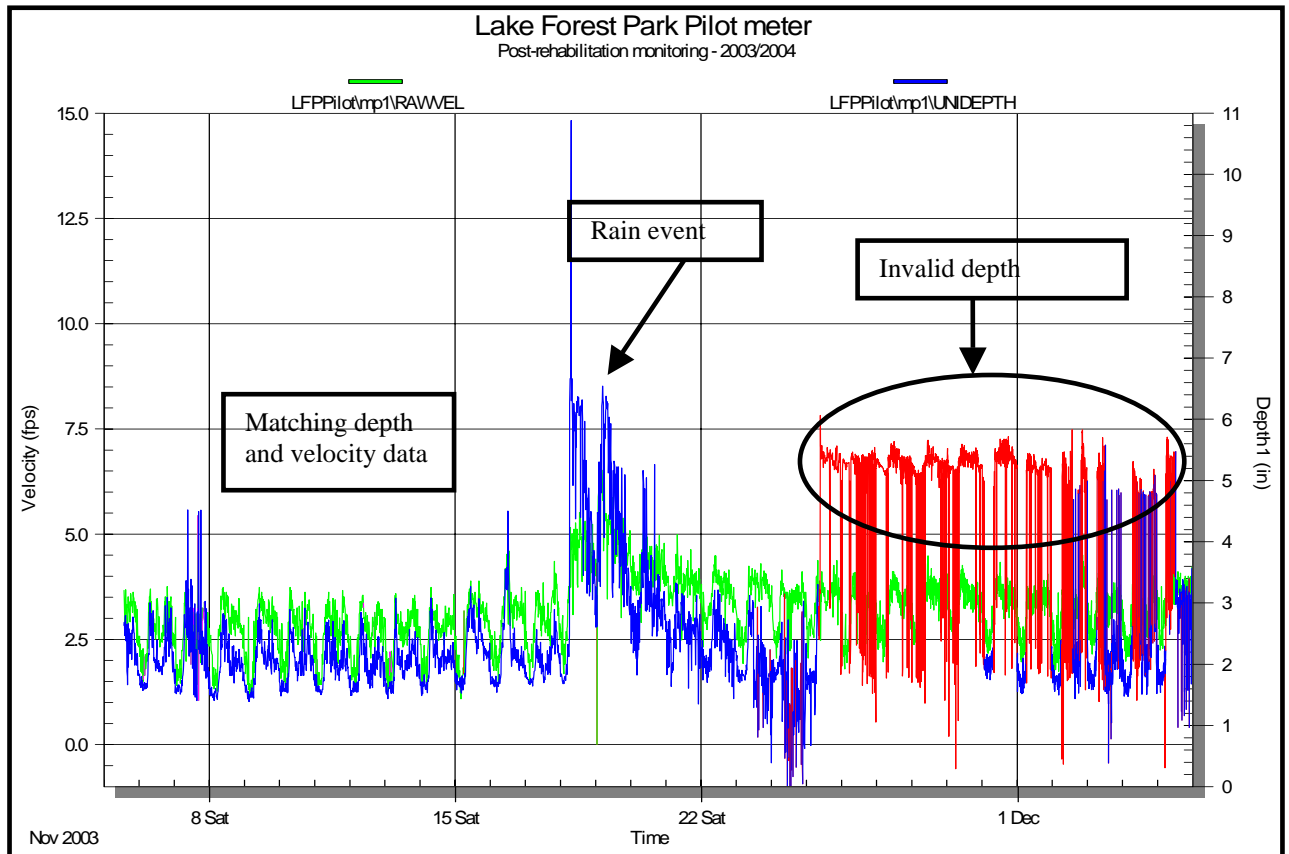
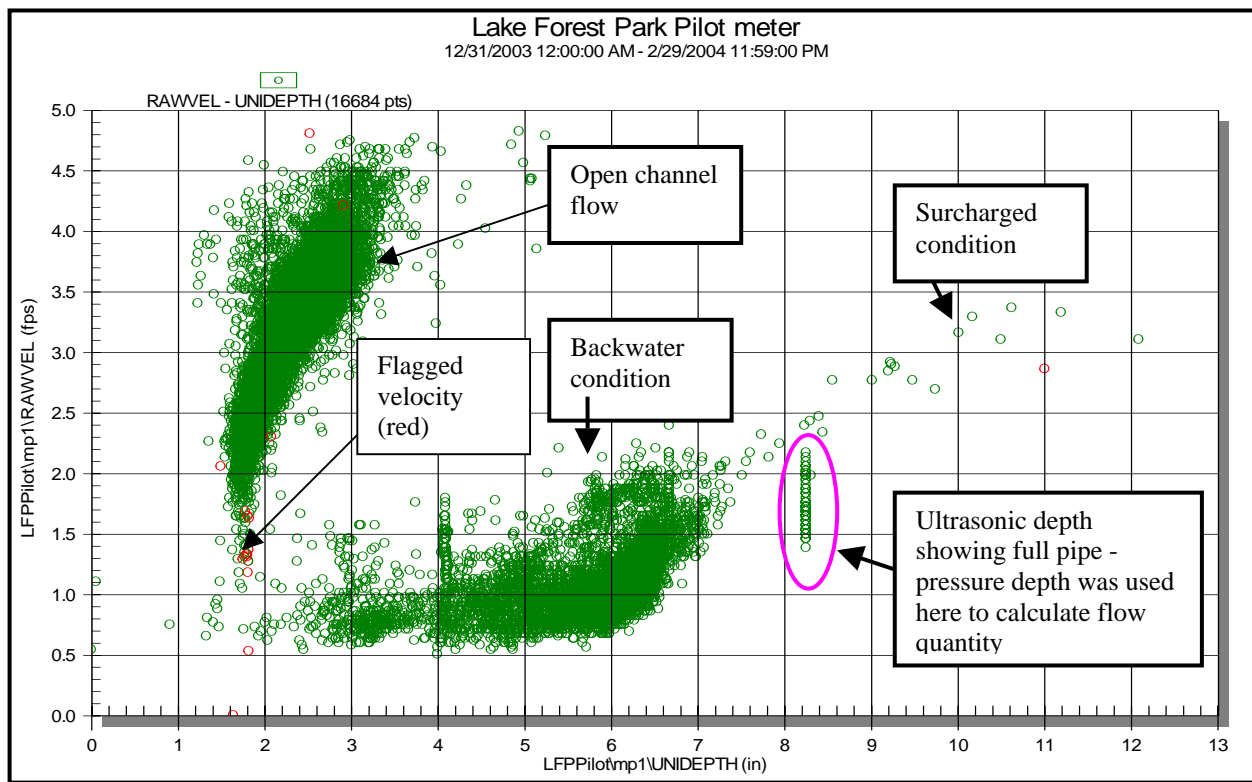
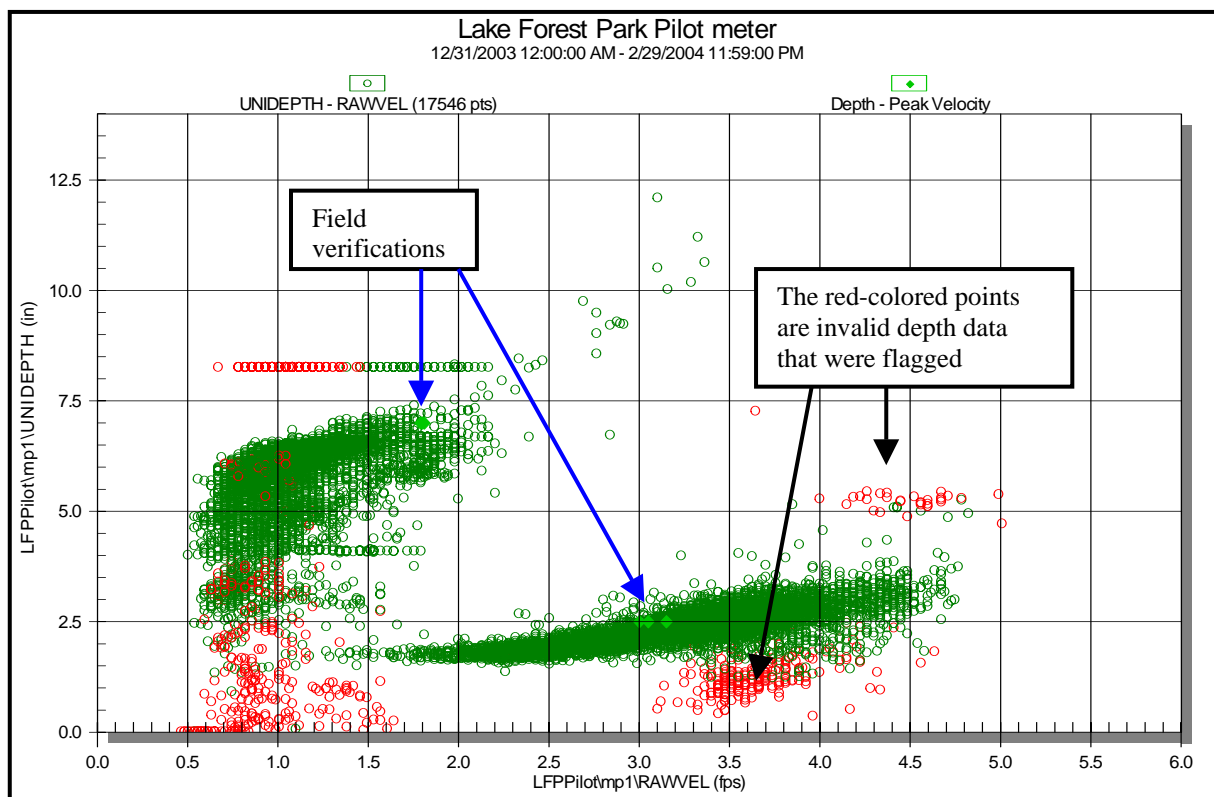


Figure 4.2 is a scattergraph showing invalid and flagged velocity data. In this graph there are some depth data that show ultrasonic depth values at full or near full pipe heights. During such periods where the ultrasonic depth sensor indicated surcharge conditions, depth data from the pressure sensor was used to calculate flow quantity. Figure 4.3 is a scattergraph plot with velocity on the x-axis and depth on the y-axis, showing the flagged depth data illustrated in Figure 4.1. Field verification data are also plotted on this scattergraph.

**Figure 4.2 - Scattergraph of Invalid Velocity Showing Open Channel Flow and Backwater and Surcharged Conditions**



**Figure 4.3 - Scattergraph of Invalid Depth Data**

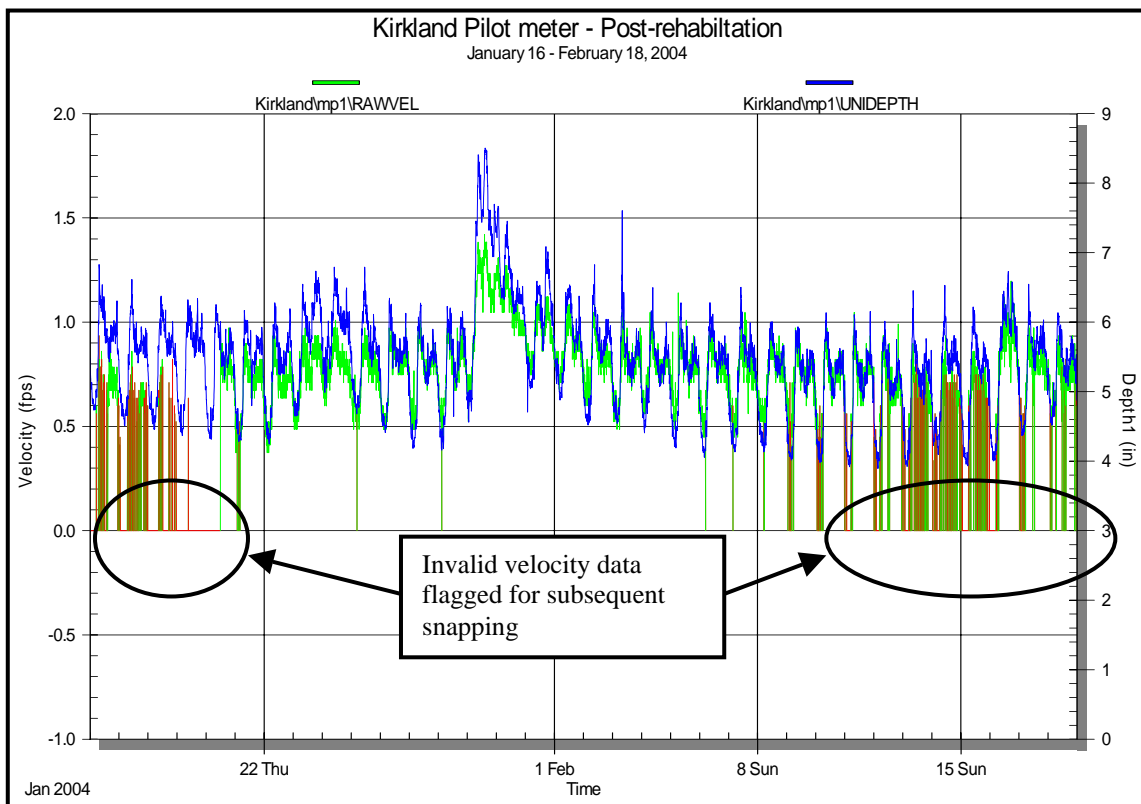


### 4.1.2 Invalid Velocity Data and Data Reconstitution

Figures 4.4 to 4.7 illustrate how invalid velocity data were identified, selected, flagged, and reconstituted. Figure 4.4 shows good depth and velocity data, with some velocity data occasionally dropping to zero. This is a relatively deep (4 to 6 inches DOF) and slow (less than 1 ft/sec for the most part) site. There were no depth dropouts corresponding to the observed velocity dropouts. The velocity dropouts could be the result of debris covering the sensor.

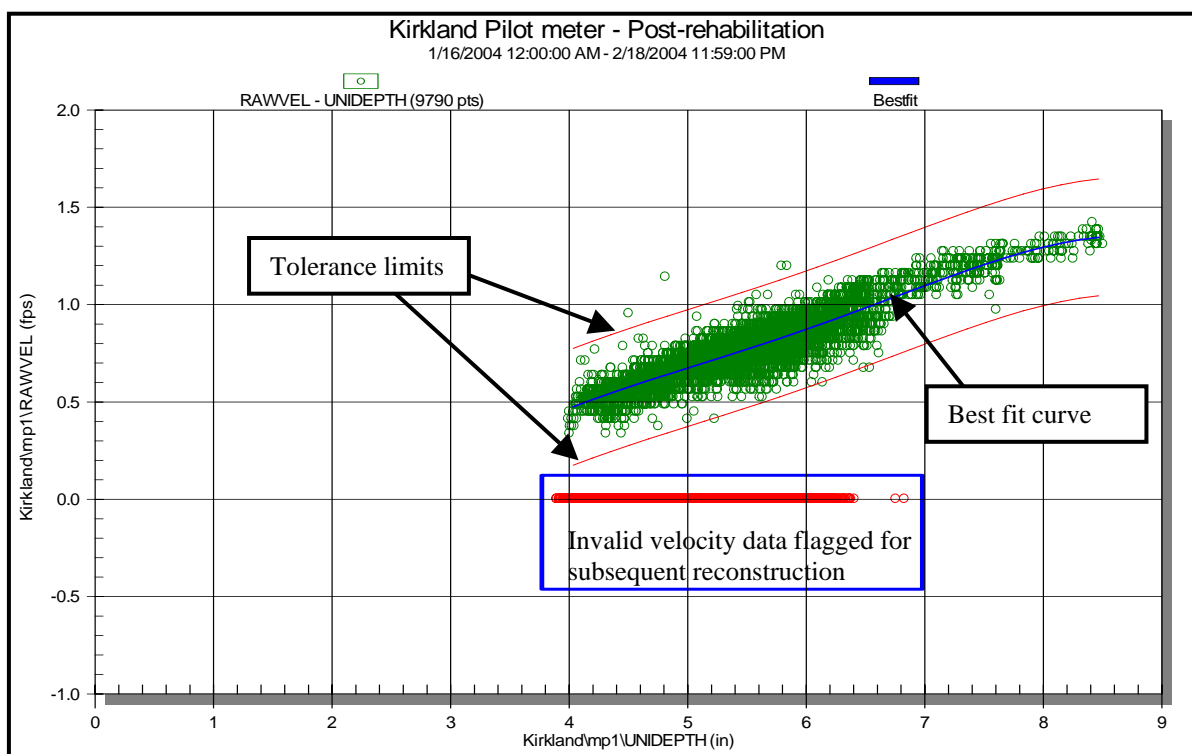
Once the invalid velocity data was identified, these data points could either be flagged (i.e., removed from further flow quantity calculation) or reconstituted based on a well-developed depth-velocity relationship at the monitoring site. The hydrograph in Figure 4.4 and scattergraph in Figure 4.5 indicate that the depth-velocity data at this site were repeatable and regular (open channel flow), satisfying the main requirement of the data reconstitution (or reconstruction) process. As shown in Figure 4.5, a best-fit curve was drawn through the depth-velocity data and tolerance limits were set.

**Figure 4.4 - Hydrograph of Invalid Velocity Data**

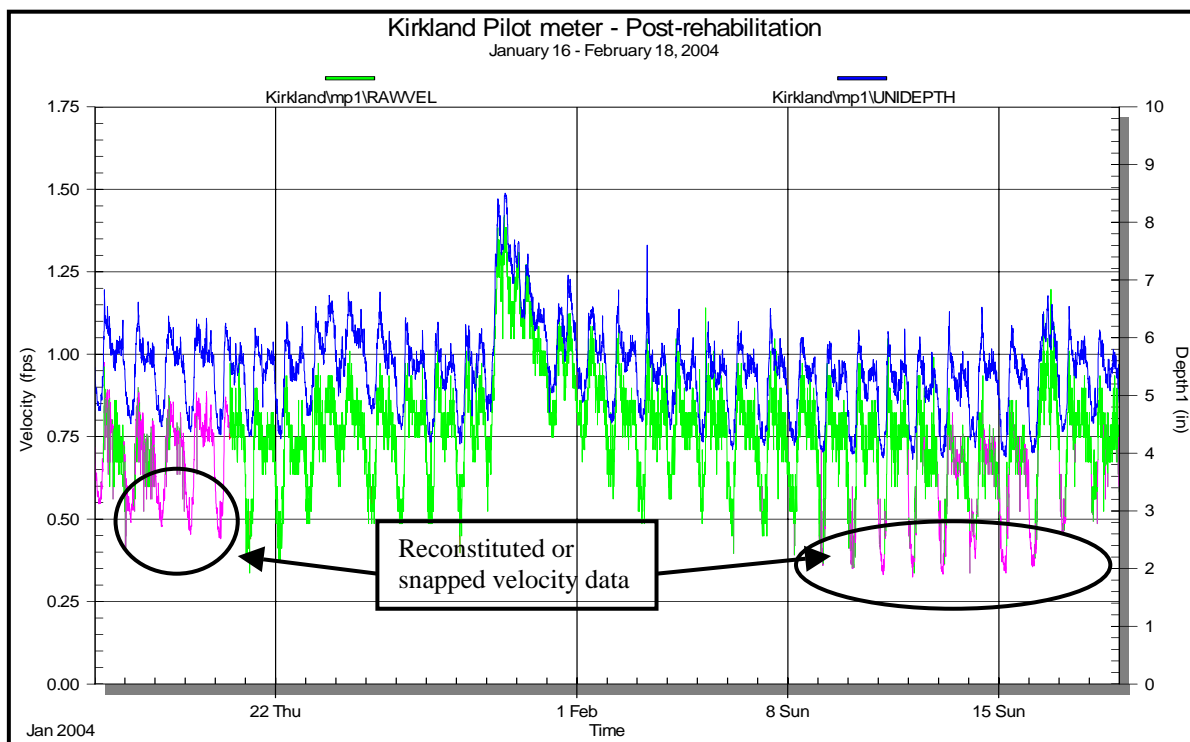


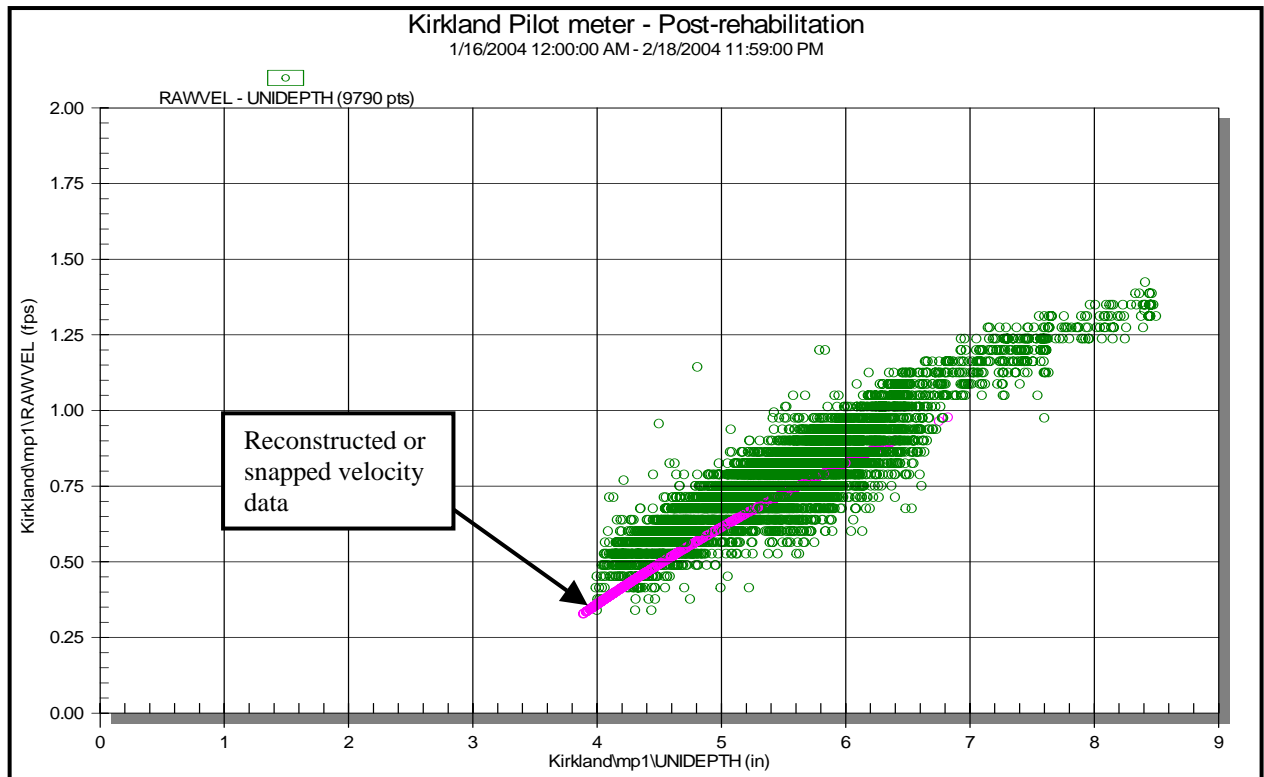
Invalid velocity data were selected (blue box in Figure 4.5) and reconstituted based on the tolerance limit and location of the invalid data (above and/or below, or within the tolerance limit). In the example shown in Figure 4.5, invalid data only below the tolerance limit were reconstituted (or snapped to curve). Figures 4.6 and 4.7 show the reconstituted velocity data in hydrograph and scattergraph plots, respectively. Reconstituted velocity data are presented as magenta colored data points on these graphs.

**Figure 4.5 - Scattergraph of Invalid Velocity Data, Best-Fit Curve, and Tolerance Limits Set for Data Reconstitution**



**Figure 4.6 - Hydrograph of Reconstituted Velocity Data**



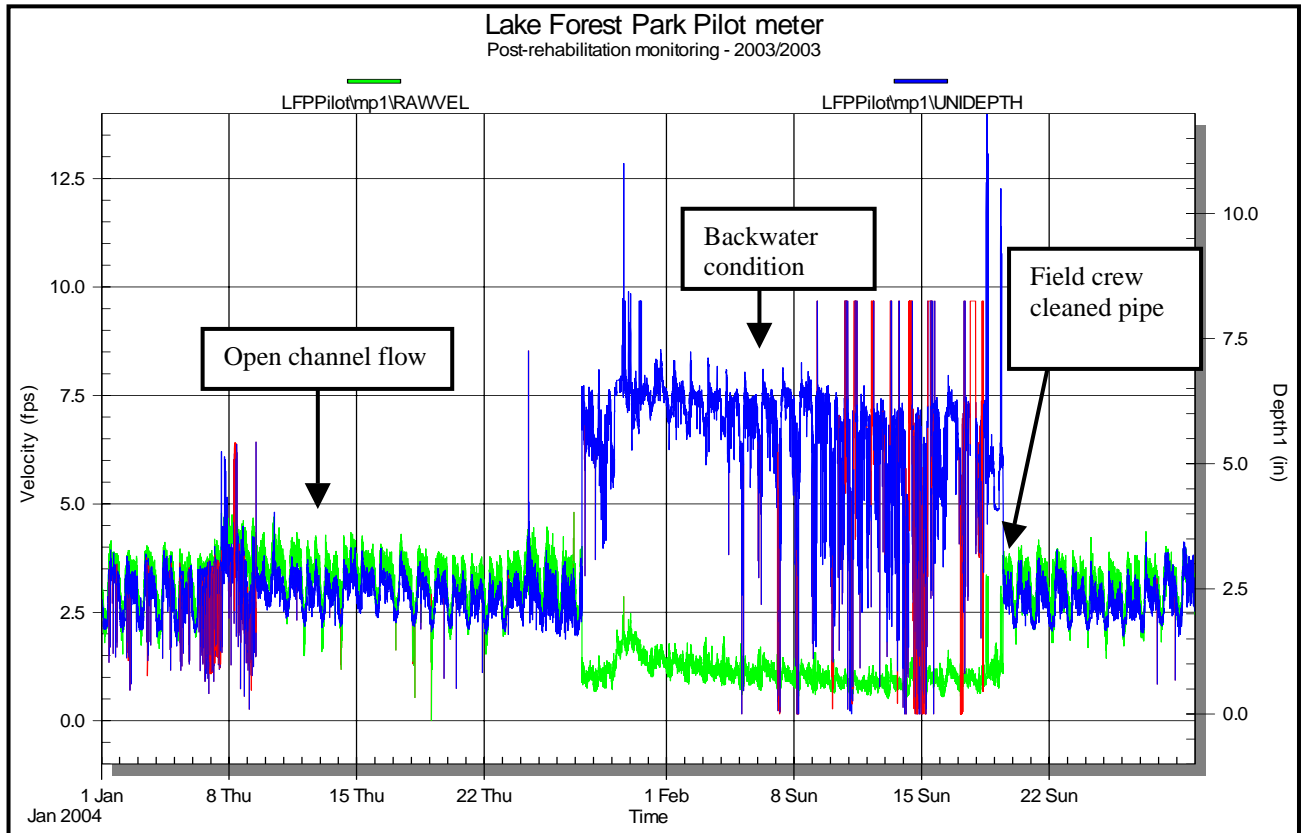
**Figure 4.7 - Scattergraph of Reconstituted Velocity Data**

#### 4.1.3 Identifying Unusual Hydraulic (Non-Open Channel Flow) Conditions

In addition to identifying and editing invalid depth and velocity data, hydrograph and scattergraph plots can be used to identify unusual hydraulics or changes in hydraulic at a monitoring site.

When the raw flow data from the Lake Forest Park Pilot Project site were reviewed, it was noted that the flow changed significantly around 1/27/04. Prior to 1/27/04, depth and velocity patterns showed a regular and repeatable pattern where increase or decrease in depth was accompanied by increase or decrease in velocity. Depth values ranged from 1.5 to 2 inches and velocity varied from about 2 to 4 ft/sec during the dry day periods. After 1/27/04, the site became deeper (4 to 7.5 inches) and slower (velocity less than 2 ft/sec). Depth and velocity varied inversely. The field crew performed a manhole investigation on 2/19/04 and found that there was a huge accumulation of trash and rags blocking the flow in the downstream side of the pipe. This temporary blockage backed up the flow, increasing the depth and decreasing the velocity. Field verification was performed during the high flow condition, then the crew removed the blocking debris. Flow returned to normal open channel flow. Figures 4.8 and 4.9 illustrate how changes in hydraulic conditions were identified using a combination of hydrograph and scattergraph plots.

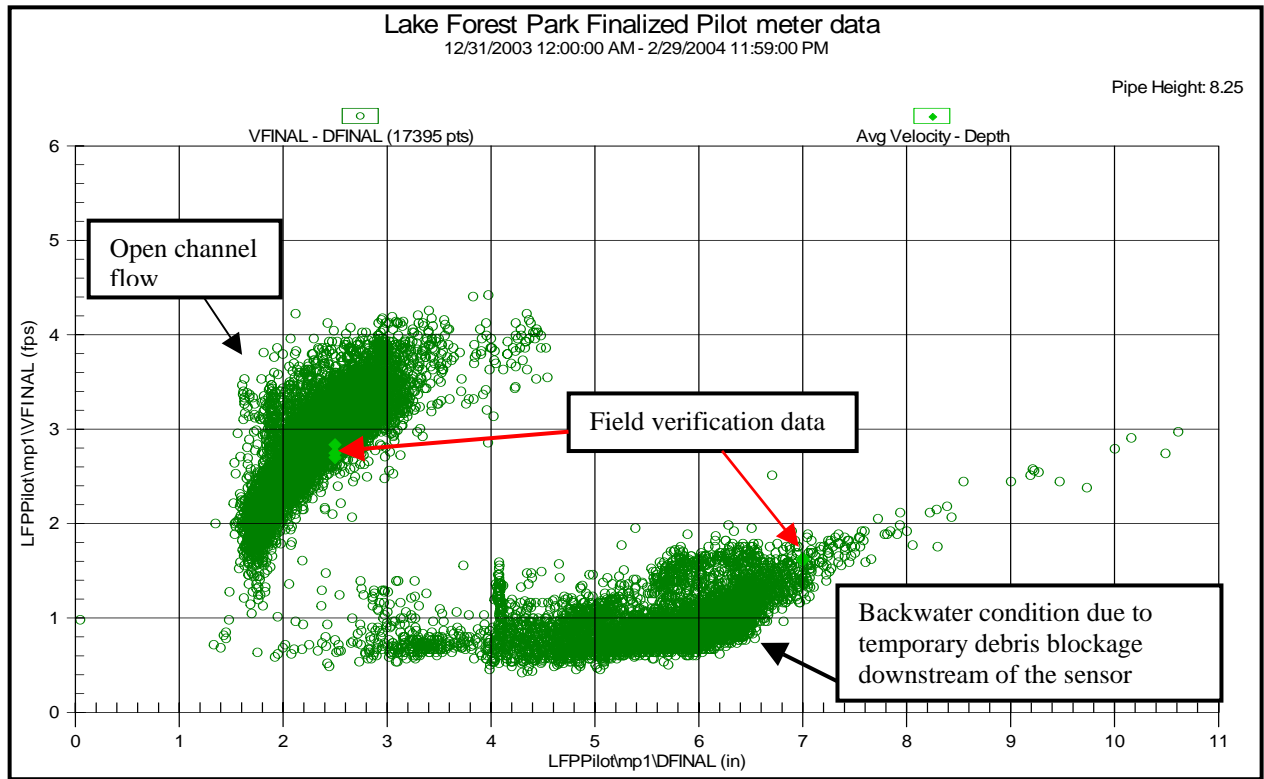
**Figure 4.8 - Hydrograph Illustrating Backwater Conditions due to Temporary Debris Blockage and Invalid Depth Data (In Red)**



## 4.2 Using Scaling and Scrubbing Factors to Edit Data

Review of flow data collected during the 2000/2001 and 2001/2002 flow monitoring periods indicated that the flow data from the Mercer mini-basin meter might not have been reliable during peak flow times. This was verified by performing a flow test on 3/19/03. During the test, a relatively constant flow of hydrant water was added to the system. Although the flow was maintained at a relatively constant rate, the pipe surcharged and the measured flow increased from about 0.4 to 0.9 mgd. The site exhibited backwater conditions at depths greater than approximately 3 to 3.5 inches (0.4 to 0.5 mgd) caused by flow restrictions associated with the downstream manhole and/or the Lake line. The test data indicated that during such surcharge events the flow meter was calculating flow in excess of what was actually being conveyed by the system, and that flow data collected during storm events when the system surcharged were unreliable.

**Figure 4.9 - Scattergraph Illustrating Backwater Conditions due to Temporary Debris**

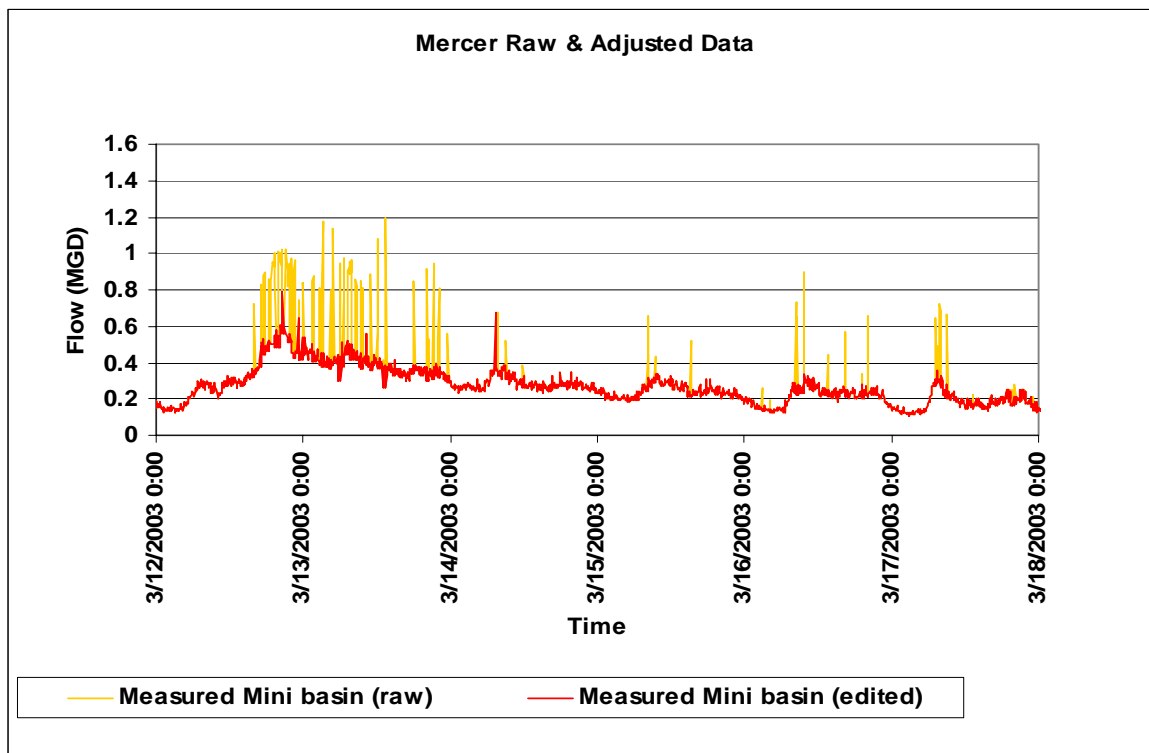


Two approaches were used to estimate the peak flows at the Mercer mini-basin meter during the 2002/2003 and 2003/2004 flow monitoring periods

#### 4.2.1 Scrubbing Factor Approach

A scrubbing routine was established based on the results of the flow test conducted on 3/19/03 and the peak-to-minimum-value ratios in a 50- to 60-minute span during rain events when the system surcharged. This routine established an empirical limit of 150 percent to make the peak flow data consistent with what was observed/measured during the calculation window. If the measured peak was greater than the minimum value (in the 1-hour span) by more than 150 percent, it was rejected and substituted with the minimum value. Otherwise, the recorded value was kept as valid data. Figure 4.10 illustrates the results of this procedure. This approach was used to edit spikes of shorter duration (less than 1 hour) during the 2002/2003 and 2003/2004 flow monitoring periods.

Figure 4.10 - An Example of Data Scrubbing



#### 4.2.2 Scaling Factor Approach

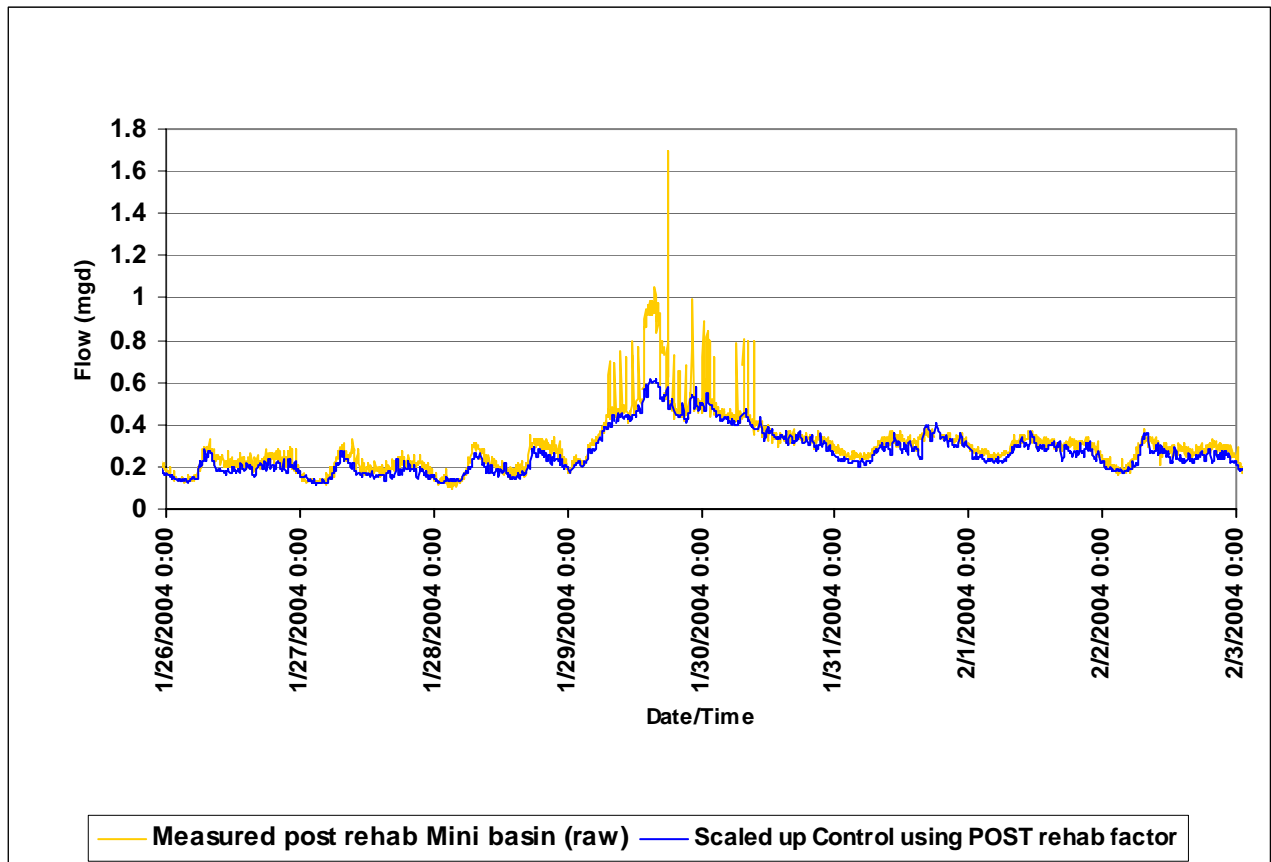
The scaling factor approach was used to estimate the peak flows (during surcharged conditions) at the Mercer Island mini-basin meter (MRC012 2001/2002) using measured flow from the Mercer Island control basin. The flow from the control basin made up about 26 percent of the total flow measured at the mini-basin (for the 3/5 to 4/11/03 time period used to generate the scaling factor). Using this relationship, the measured control basin flow was scaled up to simulate the mini-basin flow and was then compared with the measured mini-basin flow. The measured mini-basin flow was edited to remove erroneous/invalid data prior to comparison. An average scaling factor of 4.28 was calculated using this approach. This scaling factor was a better fit for wet weather than dry weather flow data.

The percent relative difference between the average "scaled up" control basin flow rate and the average measured mini-basin flow rate for the 3/5/03 to 4/11/03 time period was 5.33 percent. That is, for the time period used, the average "scaled up" control basin flow rate was 5.33 percent higher than the average measured mini-basin flow rate. When individual rain events were considered, the relative difference dropped almost by half (-2.58 percent for the period 3/12/03 to 3/13/03 and 2.41 percent for the period 3/20/03 to 3/23/03). The percent relative difference was calculated as  $\% \text{ relative difference} = [(Scaled \text{ up flow} - Measured \text{ mini-basin flow}) / Measured \text{ mini-basin flow}] \times 100$ . The low percent relative difference between the scaled up and the measured flows demonstrates that it was possible and reasonable to accurately estimate the peak flows (during

surcharged pipe conditions) at the mini-basin monitoring site using this approach. For comparison purposes, it is important to note that various submerged area/velocity flow meters, non-contact area/velocity meters, and flumes and volumetric weirs have an overall flow measurement accuracy of  $\pm 5\%$  (of the reading). Depending on the monitoring site hydraulics and/or existing flow conditions, the actual accuracy values may be lower or higher than the manufacturer's stated accuracy values.

Due to rehabilitation work done in the Mercer mini-basin during the 2003/2004 post-rehabilitation monitoring period, the scaling factor was recalculated (3.069) using post-rehabilitation flow data. The scaled-up control site data were used to replace mini-basin peak flow data only during rain events when the pipe was in a surcharged condition and the peaks were of longer duration (more than 1 hour). For smaller duration peaks, the scrubbing approach was used. Figure 4.11 shows a comparison of the raw mini-basin data and the mini-basin flow data generated by using the scaling approach.

**Figure 4.11 - Mercer Mini-Basin Data Scaled Up Using the Post-Rehabilitation Control Site Data and Post-Rehabilitation Scaling Factor**



## Section 5 - Data Quality Summary

Subjective or qualitative quality rating criteria were established and used to classify data quality into three classes: Poor, Fair, and Good. A data loss rating was also established based on the amount of data loss/gap or uptime percentage. Tables D-5.1a and D-5.1b list the criteria used for these classifications.

Tables D-5.2 and D-5.3 summarize the data quality during the pre- and post-rehabilitation flow monitoring periods. In these tables, a general summary of the data review is provided. Where applicable, data adjustments done at a particular site are also included in the data review summary. Qualitative description of the data quality is provided in order to put a level of confidence on the collected data.

As discussed in Section 4, quality and reliability of depth and velocity readings from the flow meters determine the accuracy and reliability of the resulting calculated flow quantity. Plotting depth and velocity data from the meters along with field verification results can show the reliability of the measured data.

It may be difficult to assign a certain level of confidence to flow data based only on the quality of the data collected. Other factors, including how well the flow balances between upstream and downstream sites, may also need to be taken into consideration. For example, the Kirkland control and pilot monitoring sites produced fair to good quality flow data. Minimal editing was performed and some adjustments to the raw flow data were done based on field observations and verifications. When flow from the upstream (control meter) and the downstream (pilot meter) sites were compared, the net flow at the downstream site was found to be very small. This may indicate that either the flow contribution from the downstream basin was very little or the flow data at either one of the sites may be suspect. This sort of analysis requires investigating the flow schematics in detail and performing a complete velocity profile. Unfortunately, performing a complete profile requires higher flows than those observed at these sites during most of the monitoring period.

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Table D-1 - Summary of meter specifications

Manufacturer/Vendor	ADS Environmental Services (ADS)	Marsh-McBirney, Inc	Marsh-McBirney, Inc	Marsh-McBirney, Inc	Marsh-McBirney, Inc
Flow meter model	3601	Flo-Dar 460	Flo-Tote 3	Flo-Tote2 (Model 260)	Flo-Mate 2000 Velocity meter
Velocity Sensor					
Type	Peak velocity, Doppler	Radar	Electromagnetic (Faraday's Law)	Electromagnetic (Faraday's Law)	Electromagnetic (Faraday's Law)
Range (feet/sec)	- 5 to + 20	0.75 to 20	-5 to + 20	-20 to + 20	-0.05 to + 20
Resolution (feet/sec)	0.04	N/A	0.01	0.01	
Accuracy	0 to 5 feet/sec, accuracy = 1.0% of full scale (20 feet/sec) 5 to 10 feet/sec, accuracy = 1.5% full scale (20 feet/sec) 10 to 15 feet/sec, accuracy = 3.5% full scale (20 feet/sec)	$\pm 0.5\%$ of reading $\pm 0.1$ feet/sec	$\pm 2\%$ of reading, $\pm 0.05$ zero stability at 0 to + 10 ft/sec	$\pm 2\%$ of reading $\pm$ zero stability	$\pm 2\%$ of reading plus zero stability
Repeatability	N/A	N/A	N/A		
Zero Stability	N/A	N/A	$\pm 0.05\%$ feet/sec	$\pm 0.05\%$ feet/sec	$\pm 0.05\%$ feet/sec
Depth Sensor					
Type	Quad redundant ultrasonic	Ultrasonic	Submerged pressure sensor	Submerged pressure sensor	
Range	0 to 96 inches and a dead zone of 0.5 inches	0.25 to 60 inches	0.4 to 138 inches	0 to 138 inches	
Resolution	0.125?	N/A	0.1 inch	$\pm 0.1$ inch	
Accuracy	0.125 inches or 0.5% of reading (whichever is greater)	$\pm 1\%$ of reading $\pm 0.25$ inches	$\pm 1\%$ of reading		
Repeatability	zero drift	N/A	N/A		
Flow Measurement	N/A	$\pm 5\%$ of reading	$\pm 5\%$ of reading	N/A	
User software (for data retrieval and/or reporting)	Quadrascan; FieldScan; Profile	Flo-Ware	Flo-Ware	Flo-Ware	

N/A = Not available

*The information in this table is compiled from "features and specification" materials published by the respective vendor. Any divergence from the published information is not intentional.*

Table D-2.1. 2002/2003 Pre-rehabilitation Uptime summary report

METER ID	Start Time	End Time	Total number of days monitored	Uptime (QFINAL) <sup>a</sup>	Significant data gaps	Reason for data loss
Auburn Control	11/4/02 3:20 PM	4/23/03 10:20 AM	169.79	95.77%	data gap 3/17 to 3/23	battery-related problems; monitor malfunction
Auburn Pilot	11/4/02 12:45 PM	4/24/03 10:40 AM	170.91	98.80%		
Auburn Subtraction	11/4/02 1:50 PM	5/1/03 10:25 AM	177.86	92.06%	data gap 12/27/02 to 1/10/03	computer/software/firmware version mismatches and low batteries
Brier Control	11/5/02 11:40 AM	6/21/03 12:05 AM	227.52	80.51%	12/5 -12/6/02*;data gap 2/11 - 2/15/03 & 3/1 - 4/9/03	* = poor depth data flagged; computer/software/firmware version mismatches and low batteries
Brier Pilot	11/5/02 10:05 AM	5/30/03 11:45 PM	206.57	99.50%		
Kent Control	10/31/02 10:00 AM	5/27/03 9:45 AM	207.99	95.41%	data gap 12/31/02 - 1/9/03	battery-related problems
Kent Pilot A	10/30/02 2:30 PM	6/19/03 1:15 PM	231.95	97.72%	3/28 - 4/2/03	battery-related problems
Kent Pilot B	10/31/02 11:30 AM	5/27/03 8:50 AM	207.89	90.74%	data gap 11/13 - 11/18/02; 3/28 - 4/9/03; 5/1 - 5/4/03	computer/software/firmware version mismatches and low batteries
Kirkland Control	11/5/02 1:10 PM	6/17/03 8:50 AM	223.82	98.28%	data gap 1/4 - 1/7/03	battery-related problems
Kirkland Pilot	11/6/02 3:05 PM	7/3/03 12:45 PM	238.91	100.00%		
Mercer Control	11/1/02 9:50 AM	7/21/03 12:40 PM	262.12	97.64%	data gap - 11/18/02 partial; 4/27 - 4/30/03; 5/25 - 5/28/03	battery-related problems
Mercer Mini	3/5/03 10:50 AM	4/20/03 6:55 AM	45.84	95.16%		
Mercer Pilot	10/31/02 1:30 PM	7/21/03 11:35 AM	262.92	87.64%	11/18/02 partial day; 1/1 -1/3/03*; 2/8 - 2/11; 3/12 - 3/26; 4/16-4/29/03**	* = poor depth data flagged;** = computer/software/firmware version mismatches and low batteries
Redmond Control	11/1/02 11:05 AM	7/22/03 8:10 AM	262.88	99.62%	11/18 - 11/19/02 partial day	
Redmond Mini	12/12/02 12:50 PM	6/1/03 7:20 PM	171.27	99.85%		
Redmond Pilot	11/1/02 12:05 PM	7/22/03 9:40 AM	262.90	69.71%	data gaps 12/12/02 - 1/2/03; 1/22 - 1/31/03; 3/11 - 4/2/03; 4/29 - 5/27/03	computer/software/firmware version mismatches and low batteries
Skyway Control	10/29/02 2:30 PM	5/2/03 8:45 AM	184.76	94.60%	data gap 12/23/02 - 1/2/03	battery-related problems
Skyway Pilot	10/29/02 12:45 PM	5/2/03 9:30 AM	184.86	99.98%		
Average			205.60	94.05%		

No Uptime	Complete data loss - % good data is <0
Limited Uptime	Partial loss - % good data is > 0 and <80
Perfect Uptime	% good data is > 80

a = Uptime is the percentage of data points that were recorded by a flow meter and considered valid. The Report is based on QFINAL and a 5 minute data interval unless noted

Table D-2.2. 2003/2004 Post-rehabilitation Uptime summary report

METER ID	Start Time	End Time	Total number of days monitored	Uptime (QFINAL) <sup>a</sup>	Significant data gaps	Reason for data loss
Auburn Control	10/8/2003 13:45	2/4/2004 10:10	118.85	98.35%	Data loss : Partial day - 12/29/03; Whole day: 12/30 and 12/31/03	battery-related problems
Auburn Pilot	10/27/2003 12:45	2/4/2004 10:25	99.90	98.93%	Data loss : Partial day - 11/16 and 11/17/03	battery-related problems
Auburn Subtraction	10/27/2003 13:30	2/4/2004 11:00	99.90	93.57%	Data loss : Partial day - 11/25*, 11/26*, 12/24, and 12/29/03; Whole day: 12/25 - 12/28/03.	* = meter pulled for MH construction to seal leak; battery-related problems
Brier Control	12/1/2003 14:30	2/6/2004 12:15	66.91	99.92%		
Brier Pilot	12/16/2003 9:25	2/6/2004 12:10	52.11	99.93%		
Coal Creek Control	10/31/2003 10:40	2/4/2004 11:25	96.03	99.97%		
Coal Creek Pilot	12/15/2003 10:50	2/4/2004 11:40	51.03	99.67%		
Kent Control	10/9/2003 9:00	3/8/2004 9:10	151.01	99.93%		
Kent Pilot A	1/16/2004 11:35	3/8/2004 8:45	51.88	82.90%	Data loss : Partial day - 2/2 and 2/11/04; Whole day: 2/3 - 2/10/04	battery-related problems; logger/sensor malfunction
Kent Pilot B	1/16/2004 12:35	3/8/2004 9:45	51.88	82.51%	Data loss : Partial day - 2/17 and 2/16/04; Whole day: 2/18 - 2/25/04	battery-related problems; logger/sensor malfunction
Kirkland Control	10/7/2003 12:35	2/4/2004 14:05	120.06	99.97%		
Kirkland Pilot	10/9/2003 14:15	2/4/2004 13:35	117.97	99.94%		
Lake Forest Park Control	11/3/2003 14:20	2/6/2004 9:20	94.79	98.26%		
Lake Forest Park Pilot	11/5/2003 13:45	2/6/2004 10:15	92.85	91.96%	Data loss : Partial day - 11/25, 11/30-12/12, and 12/4-12/5/03; Whole day: 11/26 - 11/29/03. The LFP Pilot meter was collected using a 15 minute data collect interval 11/5/03 to 12/05/03. The interval is 5 minutes after 12/05/03. The uptime report is generated using the 15 minute average.	Poor quality depth data flagged
Mercer Control	10/7/2003 11:40	2/4/2004 13:15	120.07	99.95%		
Mercer Mini	10/21/2003 11:00	2/4/2004 12:55	106.08	99.91%	The Mercer Mini meter was collected using a 15 minute data collect interval 10/21/03 to 11/25/03. The interval is 5 minutes after 11/25/03. The uptime report is generated using the 15 minute average.	
Mercer Pilot	10/20/2003 10:25	2/4/2004 12:50	107.10	94.37%	Data loss : Partial day - 11/18 and 11/24/03; Whole day: 11/19 - 11/23/03.	Contractor removed meter for line cleaning (with out notifying KC crew).
Northshore Control	10/31/2003 12:45	2/6/2004 11:20	97.94	99.39%		
Northshore Pilot	12/15/2003 13:10	2/6/2004 10:30	52.89	99.98%		
Redmond Control	11/21/2003 10:45	3/2/2004 13:20	102.11	99.96%		
Redmond Mini	10/21/2003 12:40	3/2/2004 12:55	133.01	99.80%		
Redmond Pilot	12/1/2003 12:45	3/8/2004 11:50	97.96	99.94%		
Ronald Control	10/31/2003 14:50	2/26/2004 14:55	118.00	99.99%		
Ronald Pilot	10/22/2003 13:40	2/26/2004 14:30	127.03	81.47%	Data loss : Partial day - 11/03, 11/13-11/14, 11/18-11/19, 11/25, 12/5, 12/22, and 12/30/03, 1/7 and 1/9/04 ; Whole day: 11/26 - 12/04, 12/23 12/29/03 and 1/8/04. Flo-Dar after 1/9/04 (ADS meter before 1/9/04)	Poor quality depth data flagged
Skyway Control	10/6/2003 11:25	2/2/2004 10:00	118.94	99.95%		
Skyway Pilot	10/9/2003 10:30	2/2/2004 9:45	115.97	99.95%		
Val Vue Control (017)	10/31/2003 9:30	2/17/2004 13:15	109.16	97.65%	Data loss : Partial day - 12/29/03; Whole day: 12/30 - 12/31/03	battery-related problem
Val Vue Pilot (019)	10/22/2003 11:05	2/17/2004 13:30	118.10	97.89%	Data loss : Partial day - 12/29 and 12/31/03; Whole day: 12/30	battery-related problem
Average			99.63	97.00%		

No Uptime	Complete data loss - % good data is <0
Limited Uptime	Partial loss - % good data is > 0 and <80
Perfect Uptime	% good data is > 80

a = Uptime is the percentage of data points that were recorded by a flow meter and considered valid. The Report is based on QFINAL and a 5 minute data interval unless noted

Table D - 3.1. Pre- and Post-rehabilitation field verification summary

Site Name	Pre-rehabilitation monitoring period		Post-rehabilitation monitoring period	
	number of site visits*	number of field verifications**	number of site visits*	number of field verifications**
Auburn Control	6	11	8	24
Auburn Pilot	7	11	8	24
Auburn Subtraction	6	12	9	25
Brier Control	9	16	6	18
Brier Pilot	6	8	5	15
Coal Creek Control	N/A	N/A	8	26
Coal Creek Pilot	N/A	N/A	4	12
Kent Control	7	22	11	57
Kent Pilot A	9	13	5	17
Kent Pilot B	9	25	5	24
Kirkland Control	5	5	8	25
Kirkland Pilot	7	11	9	25
Lake Forest Park Control	N/A	N/A	6	21
Lake Forest Park Pilot	N/A	N/A	9	29
Mercer Control	10	15	9	30
Mercer Mini	2	9	8	24
Mercer Pilot	9	17	9	27
North Shore Control	N/A	N/A	8	24
North Shore Pilot	N/A	N/A	4	12
Redmond Control	8	12	6	19
Redmond Mini	3	5	8	24
Redmond Pilot	8	11	7	21
Ronald Control	N/A	N/A	10	30
Ronald Pilot	N/A	N/A	12	36
Skyway Control	6	7	8	24
Skyway Pilot	6	7	8	24
Val Vue Control	N/A	N/A	6	18
Val Vue Pilot	N/A	N/A	8	24

\* = site visits during which field verifications were performed

\*\* = individual depth and/or velocity and/or flow quantity (weir) readings taken for field verification of meter functionality/accuracy

N/A = site not monitored during the pre-rehab flow monitoring period of 2002/2003

Table D - 3.2. Meter accuracy specifications and pre-rehabilitation depth, velocity, and flow quantity field verifications

Manufacturer/Vendor	ADS	Marsh-McBirney	Marsh-McBirney
Flow meter model	3601	Flo-Dar 460	Flo-Mate 2000 Velocity meter
Velocity Sensor			
Type	Peak velocity, Doppler	Radar	Electromagnetic
Range (feet/sec)	- 5 to + 20	0.75 to 20	-0.05 to + 20
Resolution (feet/sec)	0.04	N/A	
Accuracy	0 to 5 feet/sec, accuracy = 1.0% of full scale (20 feet/sec) 5 to 10 feet/sec, accuracy = 1.5% full scale (20 feet/sec) 10 to 15 feet/sec, accuracy = 3.5% full scale (20 feet/sec)	$\pm 0.5\%$ of reading $\pm 0.1$ feet/sec	$\pm 2\%$ of reading plus zero stability
Repeatability	N/A	N/A	
Zero Stability	N/A	N/A	$\pm 0.05\%$ feet/sec
Depth Sensor			
Type	Quad redundant ultrasonic	Ultrasonic	
Range	0 to 96 inches and a dead zone of 0.5 inches	0.25 to 60 inches	
Resolution	0.125?	N/A	
Accuracy	0.125 inches or 0.5% of reading (whichever is greater)	$\pm 1\%$ of reading $\pm 0.25$ inches	
Repeatability	zero drift	N/A	
Flow Measurement	N/A	$\pm 5\%$ of reading	
User software (for data retrieval and/or reporting)	Quadrascan; FieldScan; Profile	Flo-Ware	N/A (velocity values read from meter display)

N/A = Not available

**NOTES to consider when evaluating the field verifications**

- 1) The Marsh-McBirney Flo-Mate Model 2000 velocity meter is used to verify velocity at monitoring sites (ADS uses this meter for similar purposes)
- 2) During the 2000/01 and 2001/02 I/I flow monitoring periods, ADS Environmental Services (ADS) used the approach that depth confirmations were valid if the meter and field readings were within  $\pm 0.25$  inches
- 3) Accuracy of the Thel-Mar volumetric weir used for field verification of flow is  $\pm 5\%$  of reading
- 4) The accuracy (plus/minus) for the manually measured depth is set at 0.13 inches

**5) The information in this table is compiled from "features and specification" materials published by the respective vendor. Any divergence from the published information is not intentional.**

Table D-3.2 (continued)

**AUBURN CONTROL** (old Auburn Mini)

Real Time (meter measurements)			Field Measurements (manual verification)				
Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)	Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)
11/4/02 2:35 PM	4.11	2.58		11/4/02 2:35 PM	4.13	2.68	
11/4/02 2:36 PM	4.09	2.39		11/4/02 2:36 PM	4.00	2.67	
11/4/02 2:37 PM	4.17	2.54		11/4/02 2:38 PM	4.00	2.68	
11/14/02 10:57 AM	4.05	1.65		11/14/02 10:57 AM	4.00	1.66	
12/10/02 11:11 AM	4.63	1.98		12/10/02 11:11 AM	4.63	1.92	
12/15/02 10:37 AM	6.40	2.66		12/15/02 10:37 AM	6.38	2.60	
12/20/02 11:37 AM	5.27	N/A		12/20/02 11:37 AM	5.25	2.75	
1/14/03 12:40 PM	5.55			1/14/03 12:40 PM	5.50		
1/14/03 12:42 PM	5.30			1/14/03 12:42 PM	5.30		
1/14/03 12:46 PM		2.88		1/14/03 12:46 PM		2.77	
1/14/03 12:48 PM		2.88		1/14/03 12:48 PM		2.82	

Kirk Harris' time (ETT QA/QC) used to avoid confusion

Table D-3.2 (continued)

**AUBURN PILOT (old Auburn Control)****Real Time (meter measurements)****Field Measurements (manual verification)**

Date/Time	Depth (in)	Velocity (fps)	Flow	Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)
			(mgd)				
11/4/02 12:11 PM	2.70	2.58		11/4/02 12:11 PM	2.63	2.49	
11/4/02 12:11 PM	2.72	2.62		11/4/02 12:11 PM	2.75	2.41	
11/4/02 12:12 PM	2.72	2.54		11/4/02 12:12 PM	2.63	2.41	
11/14/02 11:33 AM	2.02	2.32		11/14/02 11:33 AM	2.00	2.42	
12/10/02 10:40 AM	2.99	2.74		12/10/02 10:40 AM	3.00	2.97	
12/15/02 11:05 AM	4.89	3.70		12/15/02 11:05 AM	4.84	3.95	
12/20/02 12:02 PM	3.52	3.14		12/20/02 12:02 PM	3.50	3.00	
1/6/03 11:44 AM	4.64	3.52		1/6/03 11:45 AM	4.50	3.48	
1/14/03 12:07 PM	3.46			1/14/03 12:05 PM	3.63		
1/14/03 12:07 PM	3.46			1/14/03 12:07 PM	3.50		
1/14/03 12:08 PM	3.45			1/14/03 12:07 PM	3.50		
1/14/03 12:11 PM		2.80		1/14/03 12:11 PM		2.50	
1/14/03 12:13 PM		2.92		1/14/03 12:13 PM		2.80	

Kirk Harris' time (ETT QA/QC) used to avoid confusion

Table D-3.2 (continued)

**AUBURN SUBTRACTION** (old Auburn Pilot)

Real Time (meter measurements)				Field Measurements (manual verification)				Average of weir readings**
Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)	Date/Time	Depth (in)	Velocity (fps)	Flow (gpd)*	
11/4/02 1:36 PM	0.75	0.82	0.01	11/4/02 1:30 PM	0.50			
11/4/02 1:39 PM	0.77	0.72	0.01	11/4/02 1:39 PM	0.25			
11/4/02 1:41 PM	0.65	0.93	0.01	11/4/02 1:40 PM	0.38			
11/4/02 1:43 PM	0.58	1.26	0.01	11/4/02 1:42 PM	0.25			
11/14/02 11:10 AM	0.54			11/14/02 11:10 AM	0.50			
11/14/02 11:12 AM	0.50			11/14/02 11:12 AM	0.52			
12/10/02 10:39 AM	0.71	1.87	0.02	12/10/02 10:39 AM	0.63			
12/16/02 10:41 AM	0.86	2.02	0.03	12/16/02 10:41 AM	0.88	1.98		
12/20/02 11:49 AM	0.70	1.17		12/20/02 11:49 AM	0.63			
1/14/03 10:55 AM	0.85	1.22	0.02	1/14/03 10:55 AM	0.90			
1/14/03 11:06 AM	0.94	0.77	0.01	1/14/03 11:06 AM	0.89			
1/14/03 11:31 AM			17095.00	1/14/03 11:29 AM			11180 13780	12480
1/14/03 11:32 AM			12445.00	1/14/03 11:29 AM			11180 13780	12480

Kirk Harris' time (ETT QA/QC) used to avoid confusion

Weir reading after flow has stabilized in to normal flow condition

initial set up

flow in GPD

\* = weir measurements (low and high flow rate readings on the Weir's face plate)

\*\* = Average of the "high" and "low" readings from the Weir

Table D-3.2 (continued)

**BRIER CONTROL**

Real Time (meter measurements)				Field Measurements (manual verification)			Flow (mgd)
Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)	Date/Time	Depth (in)	Velocity (fps)	
11/5/02 11:38 AM	2.58	1.26	0.10				
11/5/02 11:43 AM	2.37	1.37	0.10				
11/5/02 11:46 AM	2.23	1.10	0.07	11/5/02 11:46 AM	2.50	1.21	
11/5/02 11:48 AM	2.38	1.52	0.11	11/5/02 11:47 AM	2.50	1.26	
11/21/02 12:57 PM	2.02	1.25	0.07				
11/21/02 12:58 PM	1.96	1.54	0.08	11/21/02 12:59 PM	2.00	1.20	
12/2/02 11:16 AM	2.61	0.83	0.07	12/2/02 11:15 AM	2.50	0.78	
12/6/02 11:56 AM	2.71	1.67	0.14				
12/6/02 11:57 AM	2.57	1.35	0.11				
12/6/02 11:58 AM	2.51	1.46	0.11	12/6/02 11:58 AM	2.50	1.38	
12/17/02 11:27 AM	2.41	1.12	0.08	12/17/02 11:27 AM	2.38	1.07	
1/3/03 12:15 PM	3.06	1.35		1/3/03 12:15 PM	3.10	1.28	
1/15/03 1:34 PM	2.21	1.25	0.08				
1/15/03 1:40 PM	2.13	1.45	0.09	1/15/03 1:40 PM	2.38		
1/15/03 1:40 PM	2.13	1.25	0.08	1/15/03 1:41 PM	2.08		
1/15/03 1:43 PM	2.40	1.40		1/15/03 1:42 PM		1.52	
6/19/03 11:13 AM	4.92	1.44	0.28	6/19/03 11:13 AM	4.00	0.54	clogged pipe- debris under pipe; very dirty site
6/19/03 11:18 AM	4.62	1.41	0.25				
6/19/03 11:25 AM	4.10	1.59	0.224	6/19/03 11:24 AM	3.75	0.75	
6/19/03 11:34 AM	3.85	1.33	0.19	6/19/03 11:31 AM	3.75	0.94	
7/3/2003 10:21	2.33	1.9	0.13	7/3/2003 10:22	2.20	1.55	
7/3/2003 10:28	2.30	1.16	0.08	7/3/2003 10:30	2.40	1.21	
7/3/2003 10:32	3.13	1.67	0.18				
7/3/2003 10:38	3.27	2.06	0.23	7/3/2003 10:40	2.70	1.96	

Kirk Harris' time (ETT QA/QC) used to avoid confusion

Table D-3.2 (continued)

**BRIER PILOT**

Real Time (meter measurements)				Field Measurements (manual verification)			
Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)	Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)
11/5/02 10:18 AM	2.49	1.72		11/5/02 10:12 AM	2.38	1.72	
11/5/02 10:19 AM	2.47	1.61		11/5/02 10:14 AM	2.38	1.83	
11/5/02 10:20 AM	2.48	1.57		11/5/02 10:15 AM	2.50	1.82	
11/5/02 10:21 AM	2.57	1.98					
11/5/02 10:22 AM	2.64	1.50					
11/13/02 1:20 PM	2.58	1.56		11/13/02 1:20 PM	2.50	1.48	
11/26/02 10:20 AM	2.38	1.50		11/26/02 10:20 AM	2.25	1.50	
12/2/02 11:00 AM	2.80	1.48		12/2/02 11:00 AM	2.63	1.37	
1/15/03 2:10 PM	3.08			1/15/03 2:11 PM	3.00		
1/15/03 2:12 PM	2.87			1/15/03 2:11 PM	3.00		
1/15/03 2:13 PM		1.68		1/15/03 2:12 PM		2.27	
1/15/03 2:14 PM		1.61		1/15/03 2:14 PM			1.5
7/3/2003 11:41	5:08			7/3/2003 11:48	0.9		
7/3/2003 11:48	5:09			7/3/2003 11:50	1	3.21	
7/3/2003 11:05	5:16			7/3/2003 11:54	1.8	3.5	

Kirk Harris' time (ETT QA/QC) used to avoid confusion

MONITOR NOT FUNCTIONING PROPERLY at time of cal

Table D-3.2 (continued)

## KENT CONTROL

Real Time (meter measurements)				Field Measurements (manual verification)				Average of Weir readings
Date/Time	Depth (in)	Velocity (fps)	Flow *	Date/Time	Depth (in)	Velocity (fps)	Flow**	
10/31/02 10:18 AM	0.68	2.05	0.02 MGD	10/31/02 10:19 AM	0.63			
10/31/02 10:20 AM	0.62	2.00	0.02 MGD	10/31/02 10:21 AM	0.50			
10/31/02 10:21 AM	0.61	1.98	0.02 MGD	10/31/02 10:22 AM	0.63			
10/31/02 10:23 AM	0.64	1.94	0.02 MGD	10/31/02 10:23 AM	0.63			
11/12/02 11:40 AM	0.73	2.02	0.02 MGD					
11/12/02 11:58 AM	0.69	1.99	0.02 MGD					
11/12/02 12:04 PM	0.85	2.09	26801	11/12/02 12:04 PM	0.75		25860	23170 24515
11/18/02 9:48 AM	0.75	1.90	20221					
11/18/02 9:54 AM	0.66	2.01	17761	11/18/02 9:55 AM	0.75		20590	23170 21880
11/21/02 11:27 AM	0.72	1.56	18831	11/21/02 11:29 AM	0.75		18110	15730 16920
11/21/02 11:31 AM	0.78	1.99	22744					
12/16/02 11:32 AM	1.10	2.30	0.04 MGD	12/16/02 11:32 AM	1.00	2.50		
1/14/03 2:43 PM	1.01	2.32	0.04 MGD	1/14/03 2:43 PM	1.25			
1/14/03 2:46 PM	0.98	2.25	0.04 MGD	1/14/03 2:48 PM		1.58		
1/14/03 2:50 PM	0.88	2.25	30218	1/14/03 2:50 PM	1.00			
1/14/03 2:50 PM	0.88	2.25	30218	1/14/03 2:51 PM		1.55		
1/14/03 2:57 PM	0.91	1.93	27374	1/14/03 2:55 PM			23170	20590 21880
1/14/03 2:59 PM	1.00	2.22	35905					
1/14/03 3:00 PM	0.95	2.08	31283					
1/14/03 3:07 PM	0.84	2.12	26784	1/14/03 3:05 PM			28640	31520 30080
2/20/03 11:43 AM	0.81	2.04	24317					
2/20/03 11:45 AM	0.86	1.85	24112	2/20/03 11:45 AM	0.75			
2/20/03 11:57 AM	0.87	2.42	32320	2/20/03 12:00 PM			20590	18110 19350
2/20/03 12:05 PM	0.72	1.94	19352	2/20/03 12:02 PM			20590	18110 19350
2/20/03 12:05 PM	0.72	1.94	19352	2/20/03 12:04 PM			20590	18110 19350
2/20/03 12:07 PM	0.71	1.97	19600	2/20/03 12:07 PM	0.70			
				6/19/03 2:59 PM	0.50		5473	7301
Monitor internal battery dead - unable to fire sensors				6/19/03 3:01 PM	0.75		5473	7301
values will be compared with collected data @ corresponding time				6/19/03 3:04 PM	0.75		9243	11290

Kirk Harris' time (ETT QA/QC) used to avoid confusion

\* flow in gallons per day (GPD) unless specified

\*\* = weir measurements.

Table D-3.2 (continued)

**KENT PILOT A****Real Time (meter measurements)****Field Measurements (manual verification)**

Date/Time	Depth (in)	Velocity (fps)	Flow*	Date/Time	Depth (in)	Velocity (fps)	Flow **	Flow **	Average weir readings
10/30/02 2:20 PM	0.66	3.44	0.03 MGD	10/30/02 2:13 PM	0.38				
10/30/02 2:24 PM	0.67	3.51	0.03 MGD	10/30/02 2:24 PM	0.63				
11/12/02 12:25 PM	0.69	4.17	0.04 MGD						
11/12/02 12:34 PM	0.80	4.30	0.05 MGD	11/12/02 12:34 PM	0.75				
11/12/02 12:35 PM	0.76	4.58	0.05 MGD						
11/18/02 10:02 AM	0.67	3.86	0.04 MGD	11/18/02 10:00 AM	0.75				
11/21/02 10:40 AM	0.59	3.56	26982.00						
11/21/02 10:47 AM	0.59	3.41	25648.00	11/21/02 10:45 AM			23170	20590	21880
12/16/02 11:40 AM	0.80	5.78	0.07 MGD	12/16/02 11:46 AM	0.88	5.63			
12/20/02 10:45 AM	0.46	2.68	13930.00	12/20/02 10:45 AM	0.50		13460	11290	12375
1/14/03 3:30 PM	0.61	3.42	27073.00	1/14/03 3:29 PM	0.45				
1/14/03 3:32 PM	0.59	3.28	24553.00	1/14/03 3:31 PM	0.49				
2/20/03 1:18 PM	0.68	4.11	38173.00	2/20/03 1:18 PM	0.63				
6/19/03 2:17PM	0.58	3.44	0.03 MGD						
6/19/03 2:24PM	0.60	4.06	0.03 MGD	6/19/03 2:24PM	0.5				
				6/19/03 2:26PM	0.5				
6/19/03 2:30PM	0.58	3.65	0.03 MGD	6/19/03 2:31PM	0.5				

INSTALL Date; sensor offset adjusted

Kirk Harris' time (ETT QA/QC) used to avoid confusion

\* flow in GPD unless specified

\*\* = weir measurements in GPD. Values used are highlighted in yellow

Table D-3.2 (continued)

## Real Time (meter measurements)

## Field Measurements (manual verification)

Date/Time	Depth (in)	Velocity (fps)	Flow *	Date/Time	Depth (in)	Velocity (fps)	Flow (gpd)*	Flow (gpd)*	Average weir readings**
10/31/02 11:24 AM	0.72	2.00	0.02 MGD	10/31/02 11:25 AM	0.69				
10/31/02 11:26 AM	0.70	1.93	0.02 MGD	10/31/02 11:27 AM	0.63				
10/31/02 11:27 AM	0.70	1.98	0.02 MGD	10/31/02 11:28 AM	0.69				
11/18/02 9:21 AM	1.04	1.34	0.02 MGD						
11/18/02 9:25 AM	0.99	1.10	0.02 MGD						
11/18/02 9:38 AM	0.94	1.89	27975	11/18/02 9:40 AM	1.00	n/a	31520	28640	30080
11/21/02 11:09 AM	1.14	2.08	40684.00	11/21/02 11:10 AM	1.00	2.00			
11/21/02 11:15 AM	0.91	2.08	29618.00	11/21/02 11:12 AM	1.00	n/a	25860	28640	27250
11/26/02 11:40 AM	1.26	1.82	0.04 MGD	11/26/02 11:40 AM	1.25	1.73			
12/9/02 10:08 AM	1.19	1.46	0.03 MGD	12/9/02 10:08 AM	1.13	1.33			
12/20/02 10:35 AM	1.05	2.13	0.04 MGD	12/20/02 10:35 AM	1.00	2.10			
1/14/03 2:00 PM	1.36	1.78	0.05 MGD						
1/14/03 2:01 AM	1.07	2.16	38722.00	1/14/03 2:01 PM	0.80	n/a			
1/14/03 2:04 PM	1.05	2.07	35943.00	1/14/03 2:04 PM	1.00	n/a			
1/14/03 2:10 PM	1.07	2.10	37749.00	1/14/03 2:08 PM			25860	28640	27250
1/14/03 2:21 PM	0.90	1.97	27431.00	1/14/03 2:20 PM			23170	25866	24518
1/14/03 2:22 PM	0.90	1.84	25635.00	1/14/03 2:20 PM			23170	25866	24518
2/20/03 12:37 PM	0.98	1.92	30206.00						
2/20/03 12:39 PM	1.09	1.86	34172.00	2/20/03 12:40 PM	1.00				
				2/20/03 12:52 PM			20590	18110	19350
				2/20/03 12:53 PM			15730	1346	8538
				2/20/03 12:54 PM			15730	1346	8538
2/20/03 12:56 PM	0.87	1.71	27822	2/20/03 12:55 PM			20590	18110	19350
2/20/03 12:56 PM	0.87	1.71	27822	2/20/03 12:56 PM	0.88				
5/27/03 10:09 AM	0.93	2.04	29865						
5/27/03 10:15 AM	1.03	2.15	36491	5/27/03 10:15 AM	1.15				
5/27/03 10:15 AM	1.03	2.15	36491	5/27/03 10:20 AM			31520	28640	30080
				5/27/03 10:22 AM			31520	28640	30080
				5/27/03 10:24 AM			25860	23170	24515
5/27/03 10:29 AM	1.07	2.16	39031	5/27/03 10:29 AM	1.13				
5/27/03 10:32 AM	1.01	2.13	35331	5/27/03 10:33 AM	1.00				

Kirk Harris' time (ETT QA/QC) used to avoid confusion

\* flow in GPD unless specified

\*\* = weir measurements in GPD. Values used are highlighted in yellow

Table D-3.2 (continued)

**KIRKLAND CONTROL** (old Kirkland Pilot)

Real Time (meter measurements)				Field Measurements (manual verification)			
Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)	Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)
11/5/02 1:10 PM	3.38	1.75	0.23				
11/5/02 1:11 PM	3.32	1.76	0.22				
11/5/02 1:13 PM	3.34	1.74	0.22				
11/19/02 11:20 AM	3.82	2.09	0.32	11/19/02 11:21 AM	3.50	1.45	
11/19/02 11:23 AM	3.58	1.76	0.24	11/19/02 11:21 AM	3.63	1.52	
11/25/02 12:50 PM	3.22	1.53	0.19	11/25/02 12:50 PM	3.25	1.50	
12/3/02 11:00 AM	5.12	0.82		12/3/02 11:00 AM	5.25	0.75	
01/15/03	No field verification was done due to traffic related problems						
01/16/03	No field verification was done due to traffic related problems						
6/17/02 9:40 AM	3.57	2.01	0.28	6/17/02 9:45 AM	3	2.4	
6/17/02 9:49 AM	3.63	1.6	0.24	6/17/02 9:50 AM	2	1.13	1.13
6/17/02 10:00 AM	3.77	1.64	0.25				
please see Kirk Harris' 1/17/03 memo for details							

Table D-3.2 (continued)

**KIRKLAND PILOT** (old Kirkland Control)

Real Time (meter measurements)				Field Measurements (manual verification)			
Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)	Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)
11/6/02 12:45 PM	4.37	1.46		11/6/02 12:45 PM	4.38	1.43	
11/6/02 12:50 PM	4.41	1.46		11/6/02 12:50 PM	4.38	1.40	
11/6/02 12:53 PM	4.40	1.46		11/6/02 12:53 PM	4.38	1.46	
11/19/02 11:02 AM	4.07	1.23		11/19/02 11:02 AM	4.00	1.20	
11/25/02 11:54 AM	3.79	1.27		11/25/02 11:54 AM	3.63	1.24	
12/3/02 11:00 AM	5.12	0.82		12/3/02 11:00 AM	5.25	0.75	
12/12/02 11:43 AM	5.12						
1/15/03 12:30 PM	3.88			1/15/03 12:31 PM	3.88		
1/15/03 12:32 PM	3.91			1/15/03 12:31 PM	3.88		
1/15/03 12:33 PM		1.31		1/15/03 12:33 PM		1.27	
7/3/2003 13:46	3.75	1.23					
7/3/2003 13:54	3.95	1.23		7/3/2003 13:54	4.00	1.37	
7/3/2003 13:57	3.90	1.27		7/3/2003 13:56	4.00	1.30	
7/3/2003 13:57	3.90	1.27		7/3/2003 13:57	4.00	1.15	

Kirk Harris' times (ETT QA/QC) in the 1/17/03 memo are incorrect (1 hour difference)

Table D-3.2 (continued)

**MERCER CONTROL**

Real Time (meter measurements)				Field Measurements (manual verification)				Average of weir readings***	
Date/Time	Depth (in)	Velocity (fps)	Flow (gpd)*	Date/Time	Depth (in)	Velocity (fps)	Flow (gpd)**	Flow (gpd)**	
11/1/02 9:45 AM	0.64	4.39	0.04 MGD	11/1/02 9:45 AM	0.56				
11/12/02 9:01 AM	0.62	5.38	0.04 MGD	11/12/02 9:01 AM	0.69				
11/12/02 9:03 AM	0.63	5.08	0.04 MGD						
11/12/02 9:05 AM	0.63	1.73	0.01 MGD						
11/18/02 11:46 AM	0.39	3.63	14914	11/18/02 11:46 AM	0.38		11290	13460	12375
11/27/02 11:21 AM	0.38	4.06	0.02 MGD	11/27/02 11:21 AM	0.38				
12/2/02 9:55 AM	0.38	3.04	11779	12/2/02 9:50 AM	0.38		11290	13460	12375
12/18/02 11:15 AM	0.50	4.34	0.03 MGD	12/18/02 11:10 AM	0.50	4.32			
1/2/03 9:40 AM	1.10	6.32		1/2/03 9:41 AM	1.13	6.24			
1/16/03 11:52 AM	0.54	4.42		1/16/03 11:52 AM	0.75				
1/16/03 11:54 AM	0.65	4.48		1/16/03 11:55 AM		4.41			
7/2/2003 2:31	0.41	3.66		7/2/2003 2:28	0.8	3.6			
7/2/2003 2:31	0.41	3.66		7/2/2003 2:33	0.5	3.19			
7/2/2003 2:35	0.41	3.26		7/2/2003 2:33	0.5	3.19			
7/2/2003 2:38	0.39	3.26		7/2/2003 2:40	0.6	3.48			
7/21/03 1:39 PM	0.61	5.37		7/21/03 1:40 PM	0.5				
7/21/03 1:42 PM	0.44	5.25		7/21/03 1:42 PM	0.6				
7/21/03 1:44 PM	0.42	4.15		7/21/03 1:44 PM	0.55				

Kirk Harris' time (ETT QA/QC) used to avoid confusion

\* flow in GPD unless specified

\*\*\* = weir measurements in GPD. Values used are highlighted in yellow

Table D-3.2 (continued)

**MERCER MINI**

Real Time (meter measurements)				Field Measurements (manual verification)			
Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)	Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)
3/5/2003 10:36:00 AM*	1.75			3/5/03 10:36 AM	2.25		
3/5/03 10:37 AM	1.65			3/5/03 10:37 AM	1.88		
3/5/03 10:41 AM	1.67			3/5/03 10:41 AM	1.63		
3/5/03 10:47 AM		5.09		3/5/03 10:47 AM		4.50	
3/5/03 10:50 AM		4.41		3/5/03 10:50 AM		4.14	
3/5/03 10:53 AM		4.45		3/5/03 10:53 AM		4.7	
3/20/2003 10:49	1.92			3/20/2003 10:49	2		
3/20/2003 10:54		4.97		3/20/2003 10:54		4.21	
3/20/2003 10:56		4.64		3/20/2003 10:56		4.39	

\* = install date ; selected upairs changed

Table D-3.2 (continued)

**MERCER PILOT**

Real Time (meter measurements)				Field Measurements (manual verification)			
Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)	Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)
10/31/02 1:22 PM	0.91	0.93	0.01	10/31/02 1:23 PM	0.94		
10/31/02 1:24 PM	0.89	0.99	0.01	10/31/02 1:24 PM	0.94		
10/31/02 1:25 PM	0.91	0.91	0.01	10/31/02 1:26 PM	1.00		
11/12/02 8:32 AM	1.95	1.73	0.07	11/12/02 8:34 AM	1.96	1.71	
11/12/02 8:42 AM	2.00	1.72	0.08				
11/12/02 8:44 AM	2.09	1.23	0.06				
11/27/02 11:14 AM	0.96	1.09	0.02	11/27/02 11:14 AM	0.96	0.97	
12/2/02 9:47 AM	1.24	1.06	0.02	12/2/02 9:47 AM	1.13	0.99	
12/18/02 10:53 AM	1.84	1.34	0.05	12/18/02 10:55 AM	1.38	1.50	
12/18/02 10:58 AM	1.44	1.47	0.04				
12/18/02 11:01 AM	1.26	1.35	0.03				
1/2/03 9:30 AM	2.57	2.13		1/2/03 9:30 AM	2.50	2.10	
1/16/03 11:28 AM	1.27	1.24	0.03	1/16/03 11:30 AM	1.30		
1/16/03 11:33 AM	1.41	1.35		1/16/03 11:33 AM		1.25	
1/16/03 11:33 AM	1.41	1.35		1/16/03 11:34 AM		1.41	
7/2/2003 1:05	1.05	1.14		7/2/2003 1:06	1.00	1.35	
				7/2/2003 1:09	1.25	1.57	
7/2/2003 1:13	1.05	1.09		7/2/2003 1:15	1.25	1.20	
7/2/2003 1:17	1.98	1.04		7/2/2003 1:15	1.25	1.20	
7/21/03 12:29 PM	1.28	0.79					
				7/21/03 12:40 PM	1	0.87	
7/21/03 12:50 PM	1.23	0.91		7/21/03 12:51 PM	1	0.95	
7/21/03 12:52 PM	1.2	1		7/21/03 12:53 PM	1.9	0.9	

Kirk Harris' time (ETT QA/QC) used to avoid confusion

Table D-3.2 (continued)

**REDMOND CONTROL**

Real Time (meter measurements)				Field Measurements (manual verification)			
Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)	Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)
11/1/02 11:08 AM	2.32	1.33	0.07	11/1/02 11:08 AM	2.25	1.24	
11/1/02 11:10 AM	2.29	0.90	0.05	11/1/02 11:10 AM	2.25	1.12	
11/1/02 11:13 AM	2.44	1.20	0.07				
11/19/02 10:16 AM	2.75	1.23	0.08				
11/19/02 10:19 AM	2.81	1.74	0.12	11/19/02 10:19 AM	2.75	1.32	
11/25/02 11:05 AM	2.98	1.84	0.14	11/25/02 10:59 AM	2.00	1.62	
12/12/02 12:40 PM	2.97	2.07	0.16				
1/2/03 10:26 AM	3.00	1.48		1/2/2003 10:27AM	3.00	1.50	
1/15/03 11:01 AM	3.04	1.59		1/15/03 11:01 AM	3.00		
1/15/03 11:03 AM	2.88	1.61		1/15/03 11:04 AM		1.53	
1/15/03 11:06 AM	2.85	1.81		1/15/03 11:07 AM		1.62	
2/21/03 10:42 AM	2.86	1.86		2/21/03 10:40 AM	2.88	1.80	
7/22/03 9:07 AM	2.01		0.96				
7/22/03 9:13 AM	2.11		1.03	7/22/03 9:12 AM	1.9		0.95
				7/22/03 9:14 AM	2		1.01
7/22/03 9:16 AM	2.21		0.99	7/22/03 9:17 AM	2		1.09

Kirk Harris' time (ETT QA/QC) used to avoid confusion

Table D-3.2 (continued)

**REDMOND MINI**

Real Time (meter measurements)			Field Measurements (manual verification)				
Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)	Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)
12/12/02 12:20 PM	4.51	1.70		12/12/02 12:20 PM	4.50	1.63	
1/15/03 10:17 AM	5.09			1/15/2003 10:17:00 AM*	4.88		
1/15/03 10:20 AM	5.12			1/15/2003 10:21:00 AM*	5.13		
1/15/03 10:25 AM		1.89		1/15/03 10:25 AM		1.89	
2/21/03 10:25 AM	7.65	0.93		2/21/03 10:28 AM	7.63	0.90	

Kirk Harris' time (ETT QA/QC) used to avoid confusion

\* = The offset in the LIF (in the laptop used for data collection/verification) was set at 1.50. The field measurements are adjusted by 0.25 inches to match the correct offset value (1.75) used to record the depth data. This was applied only to the 1/15/03 field verification and doesn't affect the data collected by the meter (which records data using the correct offset value of 1.75 inches)

Table D-3.2 (continued)

## REDMOND PILOT

## Real Time (meter measurements)

## Field Measurements (manual verification)

Date/Time	Depth (in)	Velocity (fps)*	Flow (mgd)	Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)
11/1/02 12:01 PM	2.50	1.54	0.12				
11/1/02 12:04 PM	2.62	1.78	0.15	11/1/02 12:03 PM	2.50	1.00	Install date
11/19/02 10:29 AM	2.74	1.56	0.14	11/19/02 10:29 AM	2.76	1.32	
11/25/02 11:30 AM	2.89	1.65	0.15	11/25/02 11:30 AM	2.88	1.62	
12/12/02 12:48 PM	2.69	1.78	0.15				
1/2/03 10:42 AM	3.00	1.41		1/2/03 10:42 AM	3.00	1.38	
1/15/03 11:38 AM	2.75	1.86	0.16	1/15/03 11:38 AM	2.75		
1/15/03 11:40 AM		1.54		1/15/03 11:40 AM		1.30	
1/15/03 11:41 AM		1.44		1/15/03 11:42 AM		1.24	
2/21/03 10:48 AM	2.83	1.24		2/21/03 10:49 AM	2.88	1.2	
7/22/03 9:40 AM	2.81	1.89					
7/22/03 9:48 AM	2.86	1.22		7/22/03 9:47 AM	2.75	0.99	
7/22/03 9:50 AM	2.94	1.24		7/22/03 9:49 AM	2	1.1	
				7/22/03 9:51 AM	2.75	1.1	

Kirk Harris' time (ETT QA/QC) used to avoid confusion

\* = velocity pattern changed on February 5, 2003 after the sensor and monitor were swapped(changed) at this site. The velocity pattern changed after this date, but the depth pattern remained the same. Depth and velocity tracking very well after the swap on 2/5/03. The pattern change is due to the re positioning of the sensor producing a better velocity profile.

Table D-3.2 (continued)

**SKYWAY CONTROL**

Real Time (meter measurements)				Field Measurements (manual verification)			
Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)	Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)
10/29/02 2:34 PM	0.78	1.97	0.02				
10/29/02 2:35 PM	0.76	2.01	0.02				
11/12/02 10:06 AM	2.28	3.02	0.16	11/12/02 10:06 AM	2.25	3.05	
11/18/02 10:45 AM	0.93	2.29	0.03	11/18/02 10:47 AM	1.00	2.32	
12/18/02 11:55 AM	1.98	2.89	0.12	12/18/02 11:55 AM	2.80	2.00	
1/2/03 11:52 AM	3.05	3.13		1/2/03 11:52 AM	3.00	3.48	
1/16/03 1:04 PM	1.30	2.48	0.06	1/16/03 1:05 PM	1.25		
1/16/03 1:06 PM	1.25	1.44	0.03	1/16/03 1:05 PM	1.25		
1/16/03 1:06 PM	1.25	1.44	0.03	1/16/03 1:06 PM		2.23	
1/16/03 1:08 PM	1.25	2.52	0.06	1/16/03 1:09 PM		2.47	

Kirk Harris' time (ETT QA/QC) used to avoid confusion

Table D-3.2 (continued)

SKYWAY PILOT

Real Time (meter measurements)				Field Measurements (manual verification)			
Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)	Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)
10/29/02 12:47 PM	0.84	4.46	0.06	10/29/02 12:47 PM	0.63		INSTALL DATE measurement;Sensor offset adjusted
11/12/02 9:45 AM	1.49	7.01	0.06	11/12/02 9:45 AM	1.50	6.96	
11/18/02 10:39 AM	0.96	5.27	0.08	11/18/02 10:40 AM	1.00		
12/18/02 11:40 AM	1.50	7.22	0.22	12/18/02 11:45 AM	1.50	7.13	
1/2/03 11:25 AM	2.31	8.71		1/2/03 11:25 AM	2.30	8.20	
1/16/03 12:39 PM	1.33	6.32	0.16	1/16/03 12:39 PM	1.25		
1/16/03 12:40 PM	1.36	6.34	0.16	1/16/03 12:40 PM		5.99	

Kirk Harris' time (ETT QA/QC) used to avoid confusion

Table D-3.3. Meter accuracy specifications and post-rehabilitation depth, velocity, and flow quantity field verifications

Manufacturer/Vendor	ADS	Marsh-McBirney	Marsh-McBirney	Marsh-McBirney	Marsh-McBirney
Flow meter model	3601	Flo-Dar 460	Flo-Tote 3	Flo-Tote2 (Model 260)	Flo-Mate 2000 Velocity meter
Velocity Sensor					
Type	Peak velocity, Doppler	Radar	Electromagnetic (Faraday's Law)	Electromagnetic (Faraday's Law)	Electromagnetic (Faraday's Law)
Range (feet/sec)	- 5 to + 20	0.75 to 20	-5 to + 20	-20 to + 20	-0.05 to + 20
Resolution (feet/sec)	0.04	N/A	0.01	0.01	
Accuracy	0 to 5 feet/sec, accuracy = 1.0% of full scale (20 feet/sec) 5 to 10 feet/sec, accuracy = 1.5% full scale (20 feet/sec) 10 to 15 feet/sec, accuracy = 3.5% full scale (20 feet/sec)	± 0.5% of reading ± 0.1 feet/sec	± 2% of reading, ± 0.05 zero stability at 0 to + 10 ft/sec	± 2% of reading ± zero stability	± 2% of reading plus zero stability
Repeatability	N/A	N/A	N/A		
Zero Stability	N/A	N/A	± 0.05% feet/sec	± 0.05% feet/sec	± 0.05% feet/sec
Depth Sensor					
Type	Quad redundant ultrasonic	Ultrasonic	Submerged pressure sensor	Submerged pressure sensor	
Range	0 to 96 inches and a dead zone of 0.5 inches	0.25 to 60 inches	0.4 to 138 inches	0 to 138 inches	
Resolution	0.125?	N/A	0.1 inch	± 0.1 inch	
Accuracy	0.125 inches or 0.5% of reading (whichever is greater)	±1% of reading ± 0.25 inches	± 1% of reading		
Repeatability	zero drift	N/A	N/A		
Flow Measurement	N/A	± 5% of reading	± 5% of reading	N/A	
User software (for data retrieval and/or reporting)	Quadrascan; FieldScan; Profile	Flo-Ware	Flo-Ware	Flo-Ware	

N/A = Not available

**NOTES to consider when evaluating the field verifications**

- 1) The Marsh-McBirney Flo-Mate Model 2000 velocity meter is used to verify velocity at monitoring sites (ADS uses this meter for similar purposes)
- 2) During the 2000/01 and 2001/02 I/I flow monitoring periods, ADS Environmental Services (ADS) used the approach that depth confirmations were valid if the meter and field readings were within ± 0.25 inches
- 3) Accuracy of the Thel-Mar volumetric weir used for field verification of flow is ± 5% of reading
- 4) The accuracy (plus/minus) for the manually measured depth is set at 0.13 inches
- 5) *The information in this table is compiled from "features and specification" materials published by the respective vendor. Any divergence from the published information is not intentional.*

Table D-3.3 (continued)

**AUBURN CONTROL**

Real Time Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)	Field Measurements Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)
10/8/03 1:48 PM	3.52	2.17		10/8/03 1:45 PM	3.38	2.20	
10/8/03 1:49 PM	3.44	2.24		10/8/03 1:46 PM	3.38	2.32	
10/8/03 1:50 PM	3.57	2.92		10/8/03 1:47 PM	3.50	2.41	
				10/8/03 1:47 PM	3.50	2.41	
11/4/03 10:08 AM	4.60	1.68		11/4/03 10:09 AM	4.50	1.70	
11/4/03 10:10 AM		1.94		11/4/03 10:09 AM	4.50	1.70	
11/4/03 10:10 AM		1.94		11/4/03 10:10 AM	5.00	2.00	
11/4/03 10:12 AM		1.87		11/4/03 10:12 AM	4.50	1.68	
11/17/03 11:34 AM	5.16	2.69		11/17/03 11:35 AM	5.00	2.79	
11/17/03 11:35 AM	5.13	3.03		11/17/03 11:35 AM	5.00	2.79	
11/17/03 11:35 AM	5.13	3.03		11/17/03 11:36 AM	4.88	3.00	
11/17/03 11:37 AM	5.00	2.73		11/17/03 11:37 AM	4.88	2.90	
12/2/03 12:30 PM	5.29	2.99		12/2/03 12:30 PM	5.50	3.04	
12/2/03 12:32 PM	4.96	2.88		12/2/03 12:32 PM	5.00	2.92	
12/2/03 12:34 PM	4.82	2.95		12/2/03 12:34 PM	5.00	2.99	
12/18/03 8:00 AM	6.06	3.33		12/18/03 8:00 AM	6.00	3.26	
12/18/03 8:02 AM	5.98	3.22		12/18/03 8:02 AM	6.00	3.23	
12/18/03 8:05 AM	5.89	3.07		12/18/03 8:05 AM	6.00	3.06	
12/29/03 1:45 PM	4.99	2.51		12/29/03 1:45 PM	5.10	2.45	
12/29/03 1:47 PM	4.85	2.58		12/29/03 1:47 PM	5.00	2.50	
12/29/03 1:49 PM	4.74	2.66		12/29/03 1:49 PM	4.75	2.59	
1/15/04 12:50 PM	6.01	3.20		1/15/04 12:50 PM	5.75	3.20	
1/15/04 12:52 PM	5.85	3.25		1/15/04 12:52 PM	5.25	3.30	
1/15/04 12:55 PM	5.17	3.20		1/15/04 12:55 PM	5.25	3.20	
1/27/04 12:21 PM	4.68	2.79		1/27/04 12:25 PM	4.50	2.50	
1/27/04 12:28 PM	4.43	2.93		1/27/04 12:29 PM	5.00	2.65	
1/27/04 12:32 PM	5.58	2.96		1/27/04 12:33 PM	5.50	3.00	

Table D-3.3 (continued)

**AUBURN PILOT**

Real Time Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)	Field Measurements Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)
10/27/03 1:00 PM	2.54	2.24		10/27/03 1:00 PM	2.50	2.20	
10/27/03 1:03 PM	2.49	2.36		10/27/03 1:03 PM	2.50	2.28	
10/27/03 1:05 PM	2.58	2.88		10/27/03 1:05 PM	2.50	2.83	
11/4/03 10:57 AM	2.35	2.47		11/4/03 10:57 AM	2.50	2.47	
11/4/03 11:00 AM	2.29	2.17		11/4/03 11:00 AM	2.25	2.07	
11/4/03 11:03 AM	2.25	2.36		11/4/03 11:03 AM	2.25	2.30	
11/17/03 12:10 PM	2.75	2.84		11/17/03 12:12 PM	2.50	3.03	
11/17/03 12:13 PM	2.43	2.73		11/17/03 12:12 PM	2.50	3.03	
11/17/03 12:13 PM	2.43	2.73		11/17/03 12:14 PM	2.50	3.02	
11/17/03 12:15 PM	2.48	2.73		11/17/03 12:14 PM	2.50	3.02	
11/17/03 12:15 PM	2.48	2.73		11/17/03 12:16 PM	2.50	3.00	
12/2/03 12:53 PM	3.31	2.88		12/2/03 12:53 PM	3.38	3.00	
12/2/03 12:55 PM	3.31	3.10		12/2/03 12:55 PM	3.25	3.06	
12/2/03 12:57 PM	3.55	3.67		12/2/03 12:57 PM	3.50	3.65	
12/18/03 9:23 AM	3.26	2.79		12/18/03 9:23 AM	3.25	2.80	
12/18/03 9:25 AM	3.12	2.76		12/18/03 9:25 AM	3.13	2.69	
12/18/03 9:27 AM	3.13	2.66		12/18/03 9:27 AM	3.13	2.64	
12/29/03 2:18 PM	3.21	3.03		12/29/03 2:19 PM	3.13	3.10	
12/29/03 2:21 PM	4.15	3.18		12/29/03 2:21 PM	4.20	3.20	
12/29/03 2:23 PM	4.28	3.25		12/29/03 2:23 PM	4.20	3.20	
1/15/04 1:15 PM	4.76	3.23		1/15/04 1:15 PM	4.66	3.50	
1/15/04 1:16 PM	4.50	3.48		1/15/04 1:16 PM	4.50	3.50	
1/15/04 1:19 PM	4.46	3.44		1/15/04 1:19 PM	4.25	3.40	
1/27/04 12:59 PM	4.23	2.89		1/27/04 1:00 PM	4.25	2.85	
1/27/04 1:04 PM	4.02	2.86		1/27/04 1:05 PM	4.20	3.00	
1/27/04 1:06 PM	3.94	2.83		1/27/04 1:07 PM	3.80	2.65	

Table D-3.3 (continued)

**AUBURN SUBTRACTION**

Real Time				Field Measurements			
Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)	Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)
10/27/03 1:31 PM	2.51	5.54		10/27/03 1:31 PM	2.50	4.95	
10/27/03 1:34 PM	2.48	5.39		10/27/03 1:34 PM	2.63	5.08	
10/27/03 1:37 PM	2.52	5.37		10/27/03 1:37 PM	2.50	5.10	
11/4/03 10:32 AM	1.16	3.92		11/4/03 10:32 AM	1.00	2.25	
11/4/03 10:36 AM	0.85	1.56		11/4/03 10:36 AM	0.75	1.91	
11/4/03 10:39 AM	0.65	0.93		11/4/03 10:39 AM	0.75	1.00	
11/17/03 12:38 PM	0.7	1.22		11/17/03 12:41 PM	0.75		
11/26/03 3:38 PM	2.78	6.01		11/26/03 3:46 PM	2.5		
12/2/03 1:13 PM	3.73	6.11		12/2/03 1:13 PM	3.75	6.00	
12/2/03 1:17 PM	3.70	6.01		12/2/03 1:17 PM	3.75	5.89	
12/2/03 1:20 PM	3.68	6.00		12/2/03 1:20 PM	3.75	5.85	
12/18/03 8:46 AM	0.22	1.32		12/18/03 8:46 AM	0.25		
12/18/03 9:05 AM	2.64	5.94		12/18/03 9:05 AM	2.50	5.74	
12/18/03 9:08 AM	2.58	5.83		12/18/03 9:08 AM	2.50	5.74	
12/18/03 9:10 AM	2.48	5.77		12/18/03 9:10 AM	2.55	5.70	
12/29/03 2:37 PM	0.61	2.07		12/29/03 2:37 PM	0.50	2.00	
12/29/03 2:39 PM	0.43	1.05		12/29/03 2:39 PM	0.50	1.05	
12/29/03 2:43 PM	0.20	0.93		12/29/03 2:43 PM	0.25	0.85	
1/15/04 1:45 PM	0.20	1.26	2086.9	1/15/04 1:46 PM	0.20		
1/15/04 1:47 PM	2.86	5.57		1/15/04 1:47 PM	3.00	5.50	Pumps on
1/15/04 1:49 PM	2.80	5.64		1/15/04 1:49 PM	3.00	5.50	
1/15/04 1:53 PM	2.71	5.55		1/15/04 1:53 PM	2.90	5.50	
1/27/04 1:27 PM	2.89	4.97	0.42	1/27/04 1:29 PM	3.00	5.00	
1/27/04 1:33 PM	0.90	3.39	0.05	1/27/04 1:35 PM	0.85	3.00	
1/27/04 1:37 PM	0.57	0.87	0.01	1/27/04 1:39 PM	0.63	0.75	

Table D-3.3 (continued)

**BRIER CONTROL****Real Time****Field Measurements**

<b>Date/Time</b>	<b>Depth (in)</b>	<b>Velocity (fps)</b>	<b>Flow (mgd)</b>	<b>Date/Time</b>	<b>Depth (in)</b>	<b>Velocity (fps)</b>	<b>Flow (mgd)</b>
12/1/03 2:16 PM	4.49	1.17		12/1/03 2:18 PM	4.50	0.87	
12/1/03 2:20 PM	4.46	1.13		12/1/03 2:21 PM	4.60	0.99	
12/1/03 2:23 PM	4.51	1.14		12/1/03 2:24 PM	4.50	0.87	
12/16/03 10:03 AM	4.66	1.16		12/16/03 10:08 AM	4.50	0.95	
12/16/03 10:10 AM	4.46	1.13		12/16/03 10:11 AM	4.38	0.95	
12/16/03 10:10 AM	4.46	1.13		12/16/03 10:16 AM	4.50	1.00	
12/16/03 10:15 AM	4.66	1.17					
12/30/03 10:24 AM	4.11	1.15		12/30/03 10:24 AM	4.00	1.10	
12/30/03 10:29 AM	4.27	1.21		12/30/03 10:29 AM	4.25	1.15	
12/30/03 10:32 AM	4.10	1.10		12/30/03 10:32 AM	4.00	0.98	
1/14/04 1:13 PM	4.65	1.80		1/14/04 1:14 PM	4.50	1.51	
1/14/04 1:18 PM	4.89	1.72		1/14/04 1:18 PM	4.88	1.09	
1/14/04 1:25 PM	4.47	1.18		1/14/04 1:25 PM	4.50	0.94	
1/29/04 11:55 AM	5.23	1.58		1/29/04 11:55 AM	5.25	1.45	
1/29/04 11:58 AM	5.11	1.58		1/29/04 11:59 AM	5.25	1.50	
1/29/04 12:00 PM	5.20	1.56		1/29/04 12:01 PM	5.38	1.56	
2/20/04 11:55 AM	4.81	1.22		2/20/04 11:56 AM	4.75	0.88	
2/20/04 11:58 AM	4.45	1.08		2/20/04 11:56 AM	4.75	0.88	
2/20/04 12:04 PM	4.40	1.07		2/20/04 12:05 PM	4.50	0.85	
2/20/04 12:04 PM	4.40	1.07		2/20/04 12:07 PM	4.50	0.85	

Table D-3.3 (continued)

**BRIER PILOT**

<b>Real Time</b>				<b>Field Measurements</b>			
<b>Date/Time</b>	<b>Depth (in)</b>	<b>Velocity (fps)</b>	<b>Flow (mgd)</b>	<b>Date/Time</b>	<b>Depth (in)</b>	<b>Velocity (fps)</b>	<b>Flow (mgd)</b>
12/16/03 9:28 AM	2.12	3.63		12/16/03 9:30 AM	2.13	3.5	
12/16/03 9:31 AM	2.12	4.08		12/16/03 9:30 AM	2.13	3.5	
12/16/03 9:31 AM	2.12	4.08		12/16/03 9:32 AM	2.13	4.09	
12/16/03 9:33 AM	2.14	3.63		12/16/03 9:32 AM	2.13	4.09	
12/16/03 9:33 AM	2.14	3.63		12/16/03 9:34 AM	2.25	3.7	
12/30/03 11:03 AM	2.20	2.69		12/30/03 11:03 AM	2.00	2.70	
12/30/03 11:05 AM	2.16	2.77		12/30/03 11:05 AM	2.25	2.67	
12/30/03 11:07 AM	2.13	2.80		12/30/03 11:07 AM	2.00	2.77	
1/14/04 1:45 PM	2.06	3.74		1/14/04 1:45 PM	2.00	3.75	
1/14/04 1:47 PM	2.11	3.93		1/14/04 1:47 PM	2.13	4.00	
1/14/04 1:49 PM	2.31	3.97		1/14/04 1:47 PM	2.25	4.02	
1/29/04 11:22 AM	2.96	4.38		1/29/04 11:23 AM	3.00	4.36	
1/29/04 11:26 AM	2.96	4.38		1/29/04 11:27 AM	3.00	4.31	
1/29/04 11:28 AM	3.02	4.30		1/29/04 11:29 AM	3.00	4.12	
2/20/04 11:34 AM	2.62	2.99		2/20/04 11:34 AM	2.56	3.1	
2/20/04 11:35 AM	2.61	3.01		2/20/04 11:35 AM	2.56	3	
2/20/04 11:36 AM	2.58	2.89		2/20/04 11:36 AM	2.56	3	

Table D-3.3 (continued)

**COAL CREEK CONTROL****Real Time**

Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)
10/31/03 10:37 AM	2.51	1.42	
10/31/03 10:43 AM	2.83	2.00	
10/31/03 10:43 AM	2.83	2.00	
10/31/03 10:45 AM	3.00	1.27	
11/4/03 1:43 PM	2.44	1.35	
11/4/03 1:46 PM	2.25	1.38	
11/4/03 1:48 PM	2.28	1.08	
11/18/03 10:08 AM	3.33	1.68	
11/18/03 10:10 AM	3.41	1.76	
11/18/03 10:12 AM	3.26	1.68	
12/3/03 10:23 AM	3.41	2.73	
12/3/03 10:25 AM	3.31	1.80	
12/3/03 10:26 AM	3.28	1.91	
12/3/03 10:29 AM	3.23	1.83	
12/17/03 10:39 AM	3.24	1.68	
12/17/03 10:40 AM	3.36	1.85	
12/17/03 10:42 AM	3.43	1.99	
12/30/03 9:54 AM	2.93	2.09	
12/30/03 9:55 AM	3.15	2.17	
12/30/03 9:58 AM	3.21	2.17	
1/13/04 11:02 AM	3.58	1.48	
1/13/04 11:03 AM	3.60	1.45	
1/13/04 11:04 AM	3.62	1.53	
1/30/04 12:07 PM	5.47	2.09	
1/30/04 12:14 PM	5.32	2.02	
1/30/04 12:16 PM	5.45	1.98	

**Field Measurements**

Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)
10/31/03 10:36 AM	2.50	1.31	
10/31/03 10:41 AM	2.75	1.26	
10/31/03 10:43 AM	3.00	1.35	
10/31/03 10:43 AM	3.00	1.35	
11/4/03 1:36 PM	2.25		
11/4/03 1:40 PM	2.38	1.1	
11/4/03 1:45 PM	2.38	1.14	
11/4/03 1:45 PM	2.38	1.14	
11/4/03 1:48 PM	2.38	1.1	
11/18/03 10:08 AM	3.00	2.00	
11/18/03 10:10 AM	3.25	1.71	
11/18/03 10:12 AM	3.50	1.67	
12/3/03 10:23 AM		1.70	
12/3/03 10:25 AM	3.25	1.82	
12/3/03 10:26 AM	3.25	1.83	
12/3/03 10:30 AM	3.25	1.79	
12/17/03 10:39 AM	3.16	1.68	
12/17/03 10:40 AM	3.33	1.75	
12/17/03 10:42 AM	3.50	1.90	
12/30/03 9:54 AM	2.95	1.89	
12/30/03 9:56 AM	3.25	1.89	
12/30/03 9:58 AM	3.33	1.99	
1/13/04 11:02 AM	3.56	1.44	
1/13/04 11:03 AM	3.63	1.43	
1/13/04 11:04 AM	3.63	1.44	
1/30/04 12:07 PM	5.50	2.23	
1/30/04 12:14 PM	5.30	2.20	
1/30/04 12:17 PM	5.50	2.20	

Table D-3.3 (continued)

**Coal Creek Pilot****Real Time**

<b>Date/Time</b>	<b>Depth (in)</b>	<b>Velocity (fps)</b>	<b>Flow (mgd)</b>
12/15/03 11:03 AM	3.95	2.17	
12/15/03 11:06 AM	3.82	2.09	
12/15/03 11:09 AM	3.77	2.02	
12/30/03 9:18 AM	3.43	1.83	
12/30/03 9:23 AM	3.41	1.98	
12/30/03 9:30 AM	3.49	1.87	
1/13/04 11:20 AM	3.64	1.78	
1/13/04 11:21 AM	3.57	1.75	
1/13/04 11:22 AM	3.60	1.78	
1/30/04 12:26 PM	6.06	2.15	
1/30/04 12:28 PM	6.08	2.39	
1/30/04 12:30 PM	6.06	2.43	

**Field Measurements**

<b>Date/Time</b>	<b>Depth (in)</b>	<b>Velocity (fps)</b>	<b>Flow (mgd)</b>
12/15/03 11:03 AM	4.00	2.10	
12/15/03 11:06 AM	3.88	2.06	
12/15/03 11:09 AM	3.88	2.00	
12/30/03 9:19 AM	3.33	1.69	
12/30/03 9:24 AM	3.25	1.50	
12/30/03 9:30 AM	3.50	1.50	
1/13/04 11:20 AM	3.50	1.78	
1/13/04 11:21 AM	3.50	1.78	
1/13/04 11:22 AM	3.50	1.80	
1/30/04 12:26 PM	5.88	2.02	
1/30/04 12:28 PM	5.88	2.33	
1/30/04 12:30 PM	5.88	2.41	

Table D-3.3 (continued)

**KENT CONTROL****Real Time****Field Measurements**

<b>Date/Time</b>	<b>Depth (in)</b>	<b>Velocity (fps)</b>	<b>Flow (mgd)</b>	<b>Date/Time</b>	<b>Depth (in)</b>	<b>Velocity (fps)</b>	<b>Weir Flow (gpd)</b>	<b>Weir Flow (gpd)</b>	<b>Average of weir readings*</b>
10/9/03 9:46 AM	0.83	2.2	27043	10/9/03 9:45 AM	0.88				
				10/9/03 9:55 AM			28640	31520	30080
				10/9/03 9:57 AM			28640	31520	30080
10/9/03 10:04 AM	0.79	2.21	25507	10/9/03 9:59 AM			25860	28640	27250
10/9/03 10:04 AM	0.79	2.21	25507	10/9/03 10:02 AM	0.88				
11/4/03 8:55 AM	0.61	1.87			0.68				
11/4/03 8:57 AM	0.67	2.16							
11/4/03 8:59 AM	0.59	2.15							
				11/4/03 9:07 AM	0.75		18110	20590	19350
				11/4/03 9:09 AM	0.68		18110	20590	19350
11/17/03 10:00 AM	0.6	1.95	14942	11/17/03 10:00 AM	0.63				
11/17/03 10:04 AM	0.6	1.89	14640	11/17/03 10:04 AM	0.63				
				11/17/03 10:12 AM			23170	25860	24515
				11/17/03 10:14 AM			23170	25860	24515
				11/17/03 10:15 AM			18110	20590	19350
				11/17/03 10:16 AM			18110	20590	19350
11/17/03 10:22 AM	0.8	2.04	23779	11/17/03 10:17 AM			18110	20590	19350
11/17/03 10:25 AM	0.67	1.82	16540						
12/3/03 9:28 AM	0.64	1.97	20605.1	12/3/03 9:30 AM	0.63		Weir in @ 9:30		
				12/3/03 9:38 AM			20590	23170	21880
				12/3/03 9:40 AM			20590	23170	21880
				12/3/03 9:42 AM			20590	23170	21880
				12/3/03 9:43 AM			20590	23170	21880
12/3/03 9:45 AM	0.74	1.99	20756.87	12/3/03 9:45 AM	0.63		Weir out @ 9:42		
12/3/03 9:46 AM	0.73	2.07	20120.74	12/3/03 9:45 AM	0.63				
12/18/03 10:20 AM	0.64	2.06	17390.5	12/18/03 10:20 AM	0.63		Weir in @ 10:20		
				12/18/03 10:30 AM			15730	18110	16920
				12/18/03 10:32 AM			15730	18110	16920
				12/18/03 10:34 AM			15730	18110	16920
12/18/03 10:40 AM	0.65	2.06	17927.32	12/18/03 10:40 AM	0.63		Weir out @ 10:34		
12/30/03 12:46 PM	0.83	2.2	27329.07	12/30/03 12:51 PM	0.9		Weir in @ 12:52		
				12/30/03 1:07 PM			25860	28640	
				12/30/03 1:09 PM			25860	28640	

Table D-3.3 (continued)

**KENT CONTROL****Real Time****Field Measurements**

				12/30/03 1:09 PM			25860	28640
12/30/03 1:17 PM	0.78	2.22	25242	12/30/03 1:17 PM	0.75	Weir in @ 1:15		
12/30/03 1:18 PM	0.75	2.12	22492	12/30/03 1:18 PM	0.75			
1/15/04 11:33 AM	0.92	2.1	30383.23	1/15/04 11:33 AM	1	Weir in @ 11:33		
				1/15/04 11:43 AM			31520	28640
				1/15/04 11:45 AM			31520	28640
				1/15/04 11:47 AM		Weir out @ 11:4	31520	28640
				1/15/04 11:47 AM			25860	28640
1/15/04 11:53 AM	0.87	2.13	28191.76	1/15/04 11:53 AM	0.9			
1/28/04 10:50 AM	0.9	2.14	29826.75	1/28/04 10:50 AM	0.9	Weir in		
				1/28/04 11:00 AM			31520	28640
				1/28/04 11:02 AM			31520	28640
				1/28/04 11:03 AM			31520	28640
1/28/04 11:05 AM	0.75	2.14	22911.76	1/28/04 11:05 AM	0.75	Weir out		
2/11/04 9:52 AM	0.63	1.98	16236	2/11/04 9:52 AM	0.63	Weir in		
				2/11/04 10:03 AM			18110	15730
				2/11/04 10:05 AM			18110	15730
				2/11/04 10:07 AM		Weir out	18110	15730
2/11/04 10:17 AM	0.73	2.14	21967					
2/26/04 12:35 PM	0.86	2.01	26229.71	2/26/04 12:35 PM	0.85			
				2/26/04 12:36 PM		Weir in	25860	28640
				2/26/04 12:46 PM			25860	28640
				2/26/04 12:47 PM			25860	28640
				2/26/04 12:49 PM		Weir out		
2/26/04 12:51 PM	0.66	2.04		2/26/04 12:51 PM	0.75			
3/8/04 9:11 AM	0.77	2.22	24439.74	3/8/04 9:11 AM	0.75	Weir in		
				3/8/04 9:21 AM			31520	34490
				3/8/04 9:22 AM			31520	34490
				3/8/04 9:24 AM		Weir out	31520	34490
3/8/04 9:35 AM	1.09	2.31	42477.83	3/8/04 9:37 AM	1.25			
3/8/04 9:37 AM	1.1	2.49	46380.72	3/8/04 9:37 AM	1.25			

\* flow in GPD unless specified

Table D-3.3 (continued)

**KENT PILOT A****Real Time**

<b>Date/Time</b>	<b>Depth (in)</b>	<b>Velocity (fps)</b>	<b>Flow (gpd)</b>
1/16/04 11:28 AM	0.62	2.63	
1/16/04 11:33 AM	0.57	4.47	
1/28/04 10:27 AM	0.44	3.16	15348
1/28/04 10:35 AM	0.39	3.76	15554
2/11/04 8:36 AM	0.86	3.89	51652
2/11/04 8:43 AM	0.91	4.76	
2/11/04 8:49 AM	0.93	4.13	
2/26/04 12:11 PM	0.86	3.96	
2/26/04 12:18 PM	0.87	3.78	
2/26/04 12:21 PM	0.86	3.54	
3/8/04 8:49 AM	0.83	4.03	
3/8/04 8:52 AM	0.85	3.71	
3/8/04 8:58 AM	0.88	3.75	

**Field Measurements**

<b>Date/Time</b>	<b>Depth (in)</b>	<b>Velocity (fps)</b>	<b>Weir Flow (gpd) Right</b>	<b>Weir Flow (gpd) Left</b>	<b>Average of weir readings*</b>
1/16/04 11:29 AM	0.50				
1/16/04 11:33 AM	0.50				
1/28/04 10:27 AM	0.50		weir in		
1/28/04 10:30 AM			15730	18110	16920
1/28/04 10:31 AM			15730	13490	14610
1/28/04 10:33 AM			15730	13490	14610
1/28/04 10:34 AM			15730	13490	14610
1/28/04 10:35 AM	0.50		weir out		
2/11/04 8:37 AM	0.86	3.73			
2/11/04 8:45 AM	1.00	4.70			
2/11/04 8:51 AM	1.00	4.10			
2/26/04 12:12 PM	0.75				
2/26/04 12:19 PM	0.50				
2/26/04 12:21 PM	0.55				
3/8/04 8:50 AM	0.75				
3/8/04 8:52 AM	0.63				
3/8/04 8:58 AM	0.5				

\* flow in GPD unless specified

Table D-3.3 (continued)

**KENT PILOT B****Real Time****Field Measurements**

<b>Date/Time</b>	<b>Depth (in)</b>	<b>Velocity (fps)</b>	<b>Flow (mgd)</b>	<b>Date/Time</b>	<b>Depth (in)</b>	<b>Velocity (fps)</b>	<b>Flow (mgd)</b>	<b>Flow (gpd) Right</b>	<b>Flow (gpd) Left</b>	<b>Average of weir readings*</b>
1/16/04 12:34 PM	0.61	2.24	17695.57	1/16/04 12:35 PM	0.63					
1/16/04 12:37 PM	0.64	1.51	12664.75	1/16/04 12:38 PM	0.63	Weir in				
				1/16/04 12:48 PM				25860	23170	24515
				1/16/04 12:50 PM				25860	23170	24515
				1/16/04 12:52 PM				20590	18110	19350
				1/16/04 12:54 PM				20590	18110	19350
1/16/04 12:56 PM	0.66	2.14	19049.88	1/16/04 12:56 PM	0.63	Removed weir		20590	18110	19350
1/28/04 11:18 AM	0.74	1.96	20551.2	1/28/04 11:18 AM	0.75	weir in				
				1/28/04 11:28 AM				25860	23170	24515
				1/28/04 11:29 AM				25860	23170	24515
				1/28/04 11:30 AM				25860	23170	24515
1/28/04 11:42 AM	0.60	1.99	15407.47	1/28/04 11:42 AM	0.63	weir out				
2/11/04 9:17 AM	0.70	2.06	19886	2/11/04 9:20 AM	0.75	weir in				
				2/11/04 9:31 AM				25090	18110	21600
				2/11/04 9:33 AM				25090	18110	21600
				2/11/04 9:35 AM		weir out		25090	18110	21600
2/11/04 9:38 AM	0.71	2.27	22513							
2/26/04 1:00 PM	1.07	1.58	28378.32	2/26/04 1:01 PM	1.13	weir in				
				2/26/04 1:12 PM				25090	18110	21600
				2/26/04 1:13 PM				25090	28640	26865
				2/26/04 1:15 PM		weir out		25090	18110	21600
2/26/04 1:20 PM	1.04	1.80	31076.75	2/26/04 1:20 PM	1.00					
3/8/04 9:46 AM	1.28	1.17		3/8/04 9:46 AM	1.25	1.01				
3/8/04 9:49 AM	1.55	2.19		3/8/04 9:51 AM	1.50	1.25				
3/8/04 9:50 AM	1.61	1.19		3/8/04 9:51 AM	1.50	1.25				
3/8/04 9:54 AM	1.54	1.19		3/8/04 9:55 AM	1.70	1.08				

\* flow in GPD unless specified

Table D-3.3 (continued)

**KIRKLAND CONTROL****Real Time**

<b>Date/Time</b>	<b>Depth (in)</b>	<b>Velocity (fps)</b>	<b>Flow (mgd)</b>
10/7/03 1:35 PM	2.64	1.55	0.14
10/7/03 1:38 PM	2.84	1.71	0.17
10/7/03 1:45 PM	2.98	1.83	0.20
10/7/03 1:50 PM	2.85	1.59	
11/5/03 12:42 PM	2.65	1.63	
11/5/03 12:46 PM	2.92	1.50	
11/5/03 12:50 PM	2.76	1.41	
11/19/03 10:05 AM	4.29	2.13	
11/19/03 10:09 AM	3.86	2.41	
11/19/03 10:15 AM	3.82	1.92	
12/4/03 12:23 PM	2.86	1.51	
12/4/03 12:26 PM	2.9	1.68	
12/4/03 12:30 PM	2.85	1.81	
12/19/03 10:11 AM	3.14	1.89	
12/19/03 10:15 AM	3.05	1.41	
12/19/03 10:17 AM	3.01	1.45	
12/29/03 12:02 PM	3.27	1.93	
12/29/03 12:08 PM	2.99	1.84	
12/29/03 12:12 PM	2.98	1.55	
1/15/04 11:43 AM	3.28	1.87	
1/15/04 11:45 AM	3.43	1.84	
1/15/04 11:46 AM	3.57	1.54	
1/26/04 11:05 AM	3.09	1.57	
1/26/04 11:09 AM	3.24	1.48	
1/26/04 11:12 AM	3.32	1.49	

**Field Measurements**

<b>Date/Time</b>	<b>Depth (in) +/- .13</b>	<b>Velocity (fps)</b>	<b>Flow (mgd)</b>
10/7/03 1:35 PM	2.5	1.44	
10/7/03 1:38 PM	2.63	1.56	
10/7/03 1:38 PM	2.75	1.63	
10/7/03 1:40 PM	2.75	1.45	
11/5/03 12:43 PM	2.68	1.37	
11/5/03 12:47 PM	2.75	1.27	
11/5/03 12:51 PM	2.75	1.27	
11/19/03 10:06 AM	4.25	2.11	
11/19/03 10:09 AM	4.00	1.95	
11/19/03 10:16 AM	4.00	1.92	
12/4/03 12:23 PM	2.88	1.42	
12/4/03 12:27 PM	2.88	1.51	
12/4/03 12:31 PM	2.88	1.83	
12/19/03 10:11 AM	3.00	1.61	
12/19/03 10:15 AM	3.00	1.41	
12/19/03 10:17 AM	3.00	1.41	
12/29/03 12:02 PM	3.25	1.86	
12/29/03 12:08 PM	3.00	1.75	
12/29/03 12:12 PM	3.00	1.54	
1/15/04 11:43 AM	3.38	1.78	
1/15/04 11:45 AM	3.38	1.69	
1/15/04 11:46 AM	3.50	1.59	
1/26/04 11:05 AM	3.00	1.47	
1/26/04 11:09 AM	3.25	1.46	
1/26/04 11:12 AM	3.25	1.45	

Table D-3.3 (continued)

**KIRKLAND PILOT**

<b>Real Time</b>				<b>Field Measurements</b>			
<b>Date/Time</b>	<b>Depth (in)</b>	<b>Velocity (fps)</b>	<b>Flow (mgd)</b>	<b>Date/Time</b>	<b>Depth (in)</b>	<b>Velocity (fps)</b>	<b>Flow (mgd)</b>
10/9/03 2:15 PM	3.33	1.01		10/9/03 2:15 PM	3.38	1.09	
10/9/03 2:17 PM	3.40	1.12		10/9/03 2:17 PM	3.50	1.08	
10/9/03 2:20 PM	3.37	1.08		10/9/03 2:19 PM	3.50	1.12	
11/5/03 12:23 PM	5.35	0.86		11/5/03 12:23 PM	5.00	0.83	
11/5/03 12:25 PM	5.34	0.79		11/5/03 12:25 PM	5.00	0.79	
11/5/03 12:30 PM	5.28	0.90		11/5/03 12:28 PM	5.00	0.90	
11/19/03 9:45 AM	8.00	1.27		11/19/03 9:45 AM	8.50	1.34	
11/19/03 9:47 AM	7.93	1.27		11/19/03 9:47 AM	8.00	1.28	
11/19/03 9:49 AM	7.92	1.23		11/19/03 9:49 AM	8.00	1.30	
12/4/03 12:01 PM	5.36	0.82		12/4/03 12:02 PM	5.38	0.83	
12/4/03 12:02 PM	5.36	0.86		12/4/03 12:02 PM	5.38	0.83	
12/4/03 12:03 PM	5.38	0.79		12/4/03 12:03 PM	5.38	0.83	
12/4/03 12:03 PM	5.38	0.79		12/4/03 12:04 PM	5.38	0.80	
12/19/03 9:52 AM	6.31	0.97		12/19/03 9:52 AM	6.25	1.00	
12/19/03 9:54 AM	6.36	1.01		12/19/03 9:54 AM	6.25	1.00	
12/19/03 9:56 AM	6.29	1.01		12/19/03 9:56 AM	6.25	1.00	
12/29/03 11:38 AM	5.72	0.79		12/29/03 11:38 AM	5.75	0.91	
12/29/03 11:39 AM	5.68	0.79		12/29/03 11:39 AM	5.63	0.72	
12/29/03 11:40 AM	5.69	0.82		12/29/03 11:41 AM	5.50	0.84	
1/2/04 8:49 AM	6.01			1/2/04 8:49 AM	6.00		
1/15/04 11:25 AM	6.30	0.79		1/15/04 11:25 AM	6.25	0.86	
1/15/04 11:26 AM	6.31	0.82		1/15/04 11:26 AM	6.25	0.95	
1/15/04 11:27 AM	6.36	0.86		1/15/04 11:27 AM	6.25	0.97	
1/26/04 10:30 AM	5.70	0.82		1/26/04 10:30 AM	5.70	0.87	
1/26/04 10:36 AM	5.73	0.86		1/26/04 10:36 AM	5.68	0.91	
1/26/04 10:37 AM	5.72	0.86		1/26/04 10:37 AM	5.68	0.85	

Table D-3.3 (continued)

**Lake Forest Park Control**

Real Time				Field Measurements			
Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)	Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)
11/3/03 2:10 PM	3.06			11/3/03 2:10 PM	3.00		
11/3/03 2:13 PM	2.88			11/3/03 2:13 PM	3.00		
11/3/03 2:14 PM	2.94			11/3/03 2:14 PM	3.00		
11/3/03 2:15 PM		2.77		11/3/03 2:15 PM	2.00	2.66	
11/3/03 2:16 PM		3.70		11/3/03 2:16 PM		3.35	
11/3/03 2:17 PM		3.89		11/3/03 2:17 PM		3.51	
11/19/03 12:10 PM	6.20	3.29		11/19/03 12:11 PM	6.25	3.31	
11/19/03 12:12 PM	6.21	3.55		11/19/03 12:11 PM	6.25	3.31	
11/19/03 12:12 PM	6.21	3.55		11/19/03 12:13 PM	6.25	3.57	
11/19/03 12:14 PM	6.20	4.56		11/19/03 12:13 PM	6.25	3.57	
11/19/03 12:14 PM	6.20	4.56		11/19/03 12:15 PM	6.33	4.60	
12/16/03 11:54 AM	3.35	4.04		12/16/03 11:55 AM	3.25	3.93	
12/16/03 11:55 AM	3.35	4.23		12/16/03 11:55 AM	3.25	3.93	
12/16/03 11:57 AM	3.34	4.53		12/16/03 11:57 AM	3.38	4.17	
12/16/03 11:57 AM	3.34	4.53		12/16/03 11:59 AM	3.38	4.51	
12/29/03 1:52 PM	3.58	4.41		12/29/03 1:52 PM	3.50	4.39	
12/29/03 1:55 PM	3.55	3.93		12/29/03 1:55 PM	3.50	3.89	
12/29/03 1:57 PM	3.72	4.30		12/29/03 1:57 PM	3.50	4.20	
1/14/04 11:42 AM	3.92	4.49		1/14/04 11:42 AM	4.00	4.47	
1/14/04 11:45 AM	3.84	4.53		1/14/04 11:45 AM	3.88	4.32	
1/14/04 11:48 AM	3.88	4.67		1/14/04 11:48 AM	3.88	4.60	
1/29/04 1:02 PM	6.31	3.74		1/29/04 1:02 PM	6.25	3.88	
1/29/04 1:03 PM	6.31	4.53		1/29/04 1:03 PM	6.25	4.67	
1/29/04 1:04 PM	6.20	4.56		1/29/04 1:04 PM	6.25	4.63	

Table D-3.3 (continued)

**Lake Forest Park Pilot****Real Time**

<b>Date/Time</b>	<b>Depth (in)</b>	<b>Velocity (fps)</b>	<b>Flow (mgd)</b>
11/5/03 1:59 PM	2.66	3.74	
11/5/03 1:59 PM	2.66	3.74	
11/5/03 2:00 PM	2.65	3.44	
11/5/03 2:04 PM	2.47	3.48	
11/19/03 11:35 AM	5.06	4.83	
11/19/03 11:37 AM	4.86	5.31	
11/19/03 11:39 AM	5.15	5.42	
12/5/03 11:00 AM	4.27	3.93	
12/5/03 11:01 AM	3.73	3.67	
12/5/03 11:02 AM	3.30	4.11	
12/16/03 11:32 AM	3.01	3.03	
12/16/03 11:33 AM	2.73	3.06	
12/16/03 11:34 AM	2.77	3.10	
12/29/03 1:28 PM	2.41	3.37	
12/29/03 1:29 PM	2.34	3.70	
12/29/03 1:30 PM	2.32	3.18	
1/9/04 11:55 AM	2.66		
1/9/04 11:56 AM	2.75		
1/9/04 11:58 AM	2.62		
1/9/04 12:00 PM	2.91		
1/14/04 12:18 PM	2.64	3.30	
1/14/04 12:19 PM	2.53	3.00	
1/14/04 12:20 PM	2.57	2.96	

**Field Measurements**

<b>Date/Time</b>	<b>Depth (in)</b>	<b>Velocity (fps)</b>	<b>Flow (mgd)</b>
11/5/03 1:57 PM	2.00		
11/5/03 1:59 PM	2.50	3.80	
11/5/03 2:00 PM	2.68	3.38	
11/5/03 2:05 PM	2.38	3.71	
11/19/03 11:35 AM	5.00	4.87	
11/19/03 11:37 AM	5.00	5.15	
11/19/03 11:39 AM	5.00	5.32	
12/5/03 11:00 AM	4.25	4.01	
12/5/03 11:01 AM	4.00	3.57	
12/5/03 11:02 AM	3.25	4.09	
12/16/03 11:32 AM	3.13	2.94	
12/16/03 11:33 AM	2.75	3.02	
12/16/03 11:34 AM	2.88	3.09	
12/29/03 1:28 PM	2.50	3.38	
12/29/03 1:29 PM	2.25	3.68	
12/29/03 1:30 PM	2.25	3.10	
1/9/04 11:55 AM	3.00		
1/9/04 11:56 AM	3.00		
1/9/04 11:58 AM	3.00		
1/9/04 12:00 PM	3.00		
1/14/04 12:18 PM	2.50	3.15	
1/14/04 12:19 PM	2.50	3.05	
1/14/04 12:20 PM	2.50	3.00	

Table D-3.3 (continued)

**Lake Forest Park Pilot**

**Real Time**

<b>Date/Time</b>	<b>Depth (in)</b>	<b>Velocity (fps)</b>	<b>Flow (mgd)</b>
1/29/04 12:43 PM	6.97	1.83	
1/29/04 12:44 PM	6.92	1.84	
1/29/04 12:45 PM	6.93	1.91	
2/19/04 11:33 AM	2.57	3.15	
2/19/04 11:35 AM	2.51	3.3	
2/19/04 11:35 AM	2.51	3.3	

**Field Measurements**

<b>Date/Time</b>	<b>Depth (in)</b>	<b>Velocity (fps)</b>	<b>Flow (mgd)</b>
1/29/04 12:43 PM	7.00	1.79	
1/29/04 12:44 PM	7.00	1.81	
1/29/04 12:45 PM	7.00	1.80	
2/19/04 11:34 AM	2.50	3.20	
2/19/04 11:34 AM	2.50	3.20	
2/19/04 12:00 AM	2.5	3.25	

Table D-3.3 (continued)

**MERCER CONTROL****Real Time**

Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)
10/7/03 12:13 PM	0.57	4.46	31732
10/7/03 12:16 PM	weir install		
10/7/03 12:30 PM	removed weir		
10/7/03 12:32 PM	0.43	2.89	13718
10/7/03 12:32 PM	0.43	2.89	13718
10/20/03 11:56 AM	1.42	7.05	
10/20/03 12:00 PM	1.34	6.72	
10/20/03 12:03 PM	1.47	7.14	
10/20/03 12:03 PM	1.47	7.14	
11/6/03 10:44 AM	0.47	3.32	18219
11/6/03 10:51 AM	0.56	3.8	26428
11/6/03 10:54 AM	0.56	3.68	25898
11/6/03 10:57 AM	0.6	4.76	33139
11/18/03 12:11 PM	1.32	6.93	
11/18/03 12:16 PM	1.30	6.27	
11/18/03 12:18 PM	1.34	6.78	
12/3/03 12:21 PM	0.75	4.84	
12/3/03 12:23 PM	0.73	4.43	
12/3/03 12:27 PM	0.84	5.39	
12/17/03 9:39 AM	0.70	4.68	
12/17/03 9:42 AM	0.74	4.76	
12/17/03 9:44 AM	0.71	3.76	
12/30/03 11:58 AM	0.76	5.19	
12/30/03 12:00 PM	0.74	4.71	
12/30/03 12:10 PM	0.77	4.77	
1/13/04 9:55 AM	0.80	4.70	
1/13/04 10:00 AM	0.93	5.26	
1/13/04 10:04 AM	0.90	5.39	

**Field Measurements**

Date/Time	Depth (in) +/- 0.13	Velocity (fps)	Flow (mgd)	Flow (gpd)	Flow (gpd)	Average of weir readings*
10/7/03 12:13 PM	0.5					
10/7/03 12:13 PM	0.5					
10/7/03 12:25 PM	surge of water			28640	31540	30090
10/7/03 12:26 PM				13460	15730	14595
10/7/03 12:27 PM				23170	25190	24180
10/7/03 12:29 PM				11290	13640	12465
10/7/03 12:32 PM	0.5					
10/20/03 11:57 AM	1.5	6.7				
10/20/03 12:02 PM	1.5	6.43				
10/20/03 12:02 PM	1.5	6.43				
10/20/03 12:05 PM	1.5	6.94				
11/6/03 10:51 AM	0.5	3.66				
11/6/03 10:54 AM	0.5	3.52				
11/6/03 10:57 AM	0.63	4.02				
11/18/03 12:13 PM	1.38	5.90				
11/18/03 12:16 PM	1.25	6.40				
11/18/03 12:18 PM	1.25	6.75				
12/3/03 12:21 PM	0.63	4.56				
12/3/03 12:24 PM	0.68	4.32				
12/3/03 12:28 PM	0.80	4.97				
12/17/03 9:39 AM	0.75	4.70				
12/17/03 9:42 AM	0.75	4.40				
12/17/03 9:44 AM	0.75	3.86				
12/30/03 11:58 AM	0.85	5.00				
12/30/03 12:00 PM	0.75	4.75				
12/30/03 12:10 PM	0.85	4.75				
1/13/04 9:56 AM	0.88	4.34				
1/13/04 10:00 AM	0.90	4.15				
1/13/04 10:05 AM	0.90	4.53				

Table D-3.3 (continued)

**MERCER CONTROL****Real Time**

<b>Date/Time</b>	<b>Depth (in)</b>	<b>Velocity (fps)</b>	<b>Flow (mgd)</b>
1/29/04 8:38 AM	1.21	6.56	
1/29/04 8:45 AM	1.23	6.19	
1/29/04 8:48 AM	1.23	6.74	

\* flow in GPD unless specified

**Field Measurements**

<b>Date/Time</b>	<b>Depth (in) +/- 0.13</b>	<b>Velocity (fps)</b>	<b>Flow (mgd)</b>	<b>Flow (gpd)</b>	<b>Flow (gpd)</b>	<b>Average of weir readings*</b>
1/29/04 8:39 AM	1.20	6.45				
1/29/04 8:45 AM	1.25	6.00				
1/29/04 8:48 AM	1.25	6.50				

Table D-3.3 (continued)

**MERCER Mini****Real Time****Field Measurements**

Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)	Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)
10/21/03 11:09 AM	2.48	4.95		10/21/03 11:11 AM	2.50	5.10	
10/21/03 11:12 AM	2.57	5.54		10/21/03 11:11 AM	2.50	5.10	
10/21/03 11:12 AM	2.57	5.54		10/21/03 11:12 AM	2.63	5.20	
10/21/03 11:13 AM	2.96	5.50		10/21/03 11:12 AM	2.63	5.20	
10/21/03 11:13 AM	2.96	5.50		10/21/03 11:15 AM	2.75	5.10	
11/6/03 10:26 AM	1.58	3.14		11/6/03 10:27 AM	1.25	3.23	
11/6/03 10:28 AM	1.60	3.53		11/6/03 10:30 AM	1.50	3.41	
11/6/03 10:32 AM	1.70	3.84	avg.	11/6/03 10:33 AM	1.63	4.29	
		4.29	peak				
11/18/03 12:00 PM	17.62			11/18/03 12:00 PM	17.50		
11/18/03 12:01 PM	17.61			11/18/03 12:01 PM	17.50		
11/18/03 12:05 PM	17.82			11/18/03 12:04 PM	17.50		
12/3/03 12:04 PM	1.90	3.97		12/3/03 12:05 PM	2.00	3.83	
12/3/03 12:07 PM	1.97	4.11		12/3/03 12:08 PM	1.88	4.12	
12/3/03 12:09 PM	1.97	3.87		12/3/03 12:10 PM	1.88	3.94	
12/17/03 9:23 AM	2.17	4.30		12/17/03 9:23 AM	2.30	4.10	
12/17/03 9:24 AM	2.11	4.71		12/17/03 9:24 AM	2.25	4.84	
12/17/03 9:28 AM	2.13	4.81		12/17/03 9:28 AM	2.25	4.70	
12/30/03 11:39 AM	2.13	5.05		12/30/03 11:39 AM	2.10	4.85	
12/30/03 11:41 AM	1.81	4.90		12/30/03 11:41 AM	1.80	4.50	
12/30/03 11:43 AM	1.78	4.79		12/30/03 11:43 AM	1.80	4.50	
1/13/04 9:32 AM	2.27	4.91		1/13/04 9:32 AM	2.25	4.87	
1/13/04 9:36 AM	2.12	4.91		1/13/04 9:36 AM	2.00	4.89	
1/13/04 9:38 AM	2.20	4.88		1/13/04 9:38 AM	2.25	4.92	
1/29/04 9:28 AM	2.44	6.66		1/29/04 9:28 AM	2.50	6.50	
1/29/04 9:32 AM	2.40	6.51		1/29/04 9:32 AM	2.50	6.50	
1/29/04 9:34 AM	5.56	6.50		1/29/04 9:34 AM	5.60	6.50	

Table D-3.3 (continued)

**MERCER PILOT**

Real Time Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)	Field Measurements Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)
10/20/03 11:14 AM	2.75			10/20/03 11:23 AM	2.75	2.23	
10/20/03 11:22 AM	2.62	2.25		10/20/03 11:26 AM	2.75	2.17	
10/20/03 11:25 AM	2.62	2.31		10/20/03 11:30 AM	2.75	1.67	
10/20/03 11:28 AM	2.83	1.54					
11/6/03 11:18 AM	0.96	0.69		11/6/03 11:18 AM	1.00	0.65	
11/6/03 11:22 AM	0.92	0.60		11/6/03 11:22 AM	1.88	0.62	
11/6/03 11:26 AM	0.96	0.74		11/6/03 11:26 AM	1.00	0.72	
11/18/03 11:43 AM	2.88	2.45		11/18/03 11:40 AM	2.50	3.00	
11/18/03 11:43 AM	2.88	2.45		11/18/03 11:44 AM	2.50	3.10	
11/18/03 11:46 AM	2.94	2.49		11/18/03 11:44 AM	2.50	3.10	
11/18/03 11:50 AM	2.82	2.46		11/18/03 11:48 AM	2.60	2.67	
11/25/03 10:08 AM	1.52	1.38		11/25/03 10:10 AM	1.50	1.36	
11/25/03 10:13 AM	1.47	1.46		11/25/03 10:15 AM	1.40	1.47	
11/25/03 10:17 AM	1.76	1.43		11/25/03 10:15 AM	1.40	1.47	
11/25/03 10:17 AM	1.76	1.43		11/25/03 10:20 AM	1.50	1.39	
12/3/03 11:34 AM	1.82	1.50		12/3/03 11:35 AM	1.75	1.54	
12/3/03 11:40 AM	1.76	1.29		12/3/03 11:42 AM	1.75	1.31	
12/3/03 11:44 AM	1.63	1.19		12/3/03 11:45 AM	1.63	1.22	
12/17/03 8:53 AM	1.58	1.44		12/17/03 8:57 AM	1.40	1.51	
12/17/03 9:01 AM	1.56	1.39		12/17/03 9:01 AM	1.50	1.40	
12/17/03 9:04 AM	1.52	1.33		12/17/03 9:05 AM	1.50	1.27	
12/30/03 11:05 AM	1.36	1.19		12/30/03 11:06 AM	1.25	1.19	
12/30/03 11:11 AM	1.39	1.21		12/30/03 11:11 AM	1.33	1.19	
12/30/03 11:15 AM	1.45	1.27		12/30/03 11:16 AM	1.25	1.30	
1/13/04 8:52 AM	2.01	1.49	0.06				
1/13/04 8:57 AM	1.89	1.33		1/13/04 8:57 AM	1.90	1.23	
1/13/04 9:00 AM	1.97	1.41		1/13/04 9:01 AM	2.00	1.36	
1/13/04 9:04 AM	1.89	1.47		1/13/04 9:05 AM	1.85	1.45	
1/29/04 9:54 AM	2.77	2.23		1/29/04 9:54 AM	2.75	2.20	
1/29/04 9:59 AM	2.68	2.11		1/29/04 9:59 AM	2.60	2.10	
1/29/04 10:04 AM	2.60	2.08		1/29/04 10:05 AM	2.60	2.05	

Table D-3.3 (continued)

**Northshore Control****Real Time****Date/Time      Depth (in)    Velocity (fps)    Flow (mgd)**

10/31/03 12:49 PM      2.3      2.22  
 10/31/03 12:52 PM      2.25      1.53  
 10/31/03 12:55 PM      1.85      1.53

11/6/03 1:05 PM      1.64      1.57  
 11/6/03 1:08 PM      1.79      1.66  
 11/6/03 1:10 PM      2.01      1.5

11/19/03 11:01 AM      5.15      2.32  
 11/19/03 11:03 AM      5.26      2.39  
 11/19/03 11:05 AM      5.04      2.39

12/4/03 1:00 PM      3.49      1.72  
 12/4/03 1:02 PM      3.44      1.68  
 12/4/03 1:02 PM      3.44      1.68  
 12/4/03 1:04 PM      3.39      1.72  
 12/4/03 1:04 PM      3.39      1.72

12/19/03 9:12 AM      3.02      2.21  
 12/19/03 9:14 AM      3.05      2.06  
 12/19/03 9:14 AM      3.05      2.06  
 12/19/03 9:16 AM      3.32      2.24  
 12/19/03 9:16 AM      3.32      2.24

12/30/03 9:20 AM      3.4      1.91  
 12/30/03 9:23 AM      3.93      1.98  
 12/30/03 9:25 AM      3.91      1.94

1/15/04 1:15 PM      3.82      1.94  
 1/15/04 1:16 PM      3.85      1.87  
 1/15/04 1:17 PM      3.77      1.91

1/27/04 11:20 AM      3.27      1.72  
 1/27/04 11:21 AM      3.14      1.68  
 1/27/04 11:22 AM      3.14      1.75

**Field Measurements****Date/Time      Depth (in)    Velocity (fps)    Flow (mgd)**

10/31/03 12:49 PM      2      1.88  
 10/31/03 12:52 PM      2.25      2.09  
 10/31/03 12:54 PM      2      1.48

11/6/03 1:05 PM      1.75      1.41  
 11/6/03 1:09 PM      1.75      1.42  
 11/6/03 1:11 PM      2      1.52

11/19/03 11:01 AM      5      2.39  
 11/19/03 11:03 AM      5      2.35  
 11/19/03 11:05 AM      5

12/4/03 1:01 PM      3.5      1.83  
 12/4/03 1:01 PM      3.5      1.83  
 12/4/03 1:03 PM      3.5      1.59  
 12/4/03 1:03 PM      3.5      1.59  
 12/4/03 1:05 PM      3.5      1.65

12/19/03 9:13 AM      2.88      2.18  
 12/19/03 9:13 AM      2.88      2.18  
 12/19/03 9:15 AM      2.9      2.06  
 12/19/03 9:15 AM      2.9      2.06  
 12/19/03 9:17 AM      3.25      2.14

12/30/03 9:20 AM      3.5      1.89  
 12/30/03 9:23 AM      4      2.01  
 12/30/03 9:25 AM      4      1.87

1/15/04 1:15 PM      3.75      2  
 1/15/04 1:16 PM      3.75      1.9  
 1/15/04 1:17 PM      3.75      2

1/27/04 11:20 AM      3.13      1.71  
 1/27/04 11:21 AM      3      1.65  
 1/27/04 11:22 AM      3      1.7

Table D-3.3 (continued)

**Northshore Pilot****Real Time****Date/Time****Depth (in)****Velocity (fps)****Flow (mgd)**

12/15/03 1:14 PM

2.03

1.38

12/15/03 1:16 PM

2.04

1.46

12/15/03 1:17 PM

2.06

1.46

12/30/03 9:48 AM

2.01

1.35

12/30/03 9:51 AM

2.06

1.38

12/30/03 9:53 AM

2.06

1.35

1/15/04 12:40 PM

2.22

1.57

1/15/04 12:41 PM

2.25

1.57

1/15/04 12:42 PM

2.24

1.64

1/27/04 11:45 AM

2.06

1.57

1/27/04 11:46 AM

2.10

1.42

1/27/04 11:47 AM

2.19

1.65

**Field Measurements****Date/Time****Depth (in)****Velocity (fps)****Flow (mgd)**

12/15/03 1:14 PM

2.00

1.35

12/15/03 1:16 PM

2.00

1.52

12/15/03 1:17 PM

2.00

1.54

12/30/03 9:48 AM

2.00

1.32

12/30/03 9:51 AM

2.00

1.30

12/30/03 9:53 AM

2.00

1.00

1/15/04 12:40 PM

2.25

1.51

1/15/04 12:41 PM

2.25

1.52

1/15/04 12:42 PM

2.25

1.68

1/27/04 11:45 AM

2.00

1.55

1/27/04 11:46 AM

2.13

1.38

1/27/04 11:47 AM

2.20

1.63

Table D-3.3 (continued)

**REDMOND CONTROL****Real Time**

Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)
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11/21/03 10:43 AM	2.40	1.68	
11/21/03 10:49 AM	2.54	1.77	
11/21/03 10:51 AM	2.00	2.01	
11/21/03 10:51 AM	2.00	2.01	

12/4/03 11:07 AM	1.41	1.09	
12/4/03 11:12 AM	2.31	1.31	
12/4/03 11:15 AM	1.24	1.10	
12/4/03 11:20 AM	7.41	2.62	
12/4/03 11:23 AM	7.50	2.53	
12/4/03 11:23 AM	7.50	2.53	

Blockage in Pipe

12/19/03 11:05 AM	2.39	1.60	
12/19/03 11:11 AM	2.53	1.70	
12/19/03 11:15 AM	2.44	1.79	

12/29/03 9:18 AM	1.38	0.82	
12/29/03 9:24 AM	1.53	0.94	
12/29/03 9:27 AM	1.59	0.88	

1/15/04 10:26 AM	1.91	1.74	
1/15/04 10:31 AM	2.05	1.53	
1/15/04 10:34 AM	2.09	1.30	
1/15/04 10:34 AM	2.09	1.30	

1/27/04 10:15 AM	2.30	1.41	
1/27/04 10:18 AM	2.27	1.86	
1/27/04 10:21 AM	2.27	1.40	

**Field Measurements**

Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)
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11/21/03 10:42 AM	2.50	1.43	
11/21/03 10:50 AM	2.50	1.63	
11/21/03 10:51 AM	2.50	1.65	
11/21/03 10:52 AM	2.70	1.80	

12/4/03 11:08 AM	1.50	0.89	
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Blockage in Pipe

12/4/03 11:17 AM	1.25	0.87	
12/4/03 11:22 AM	7.50	2.40	
12/4/03 11:22 AM	7.50	2.40	
12/4/03 11:25 AM	7.50	2.40	

12/19/03 11:06 AM	2.25	1.40	
12/19/03 11:12 AM	2.50	1.48	
12/19/03 11:15 AM	2.50	1.48	

12/29/03 9:18 AM	1.50	0.89	
12/29/03 9:24 AM	1.50	0.98	
12/29/03 9:27 AM	1.50	0.99	

1/15/04 10:28 AM	1.88	1.38	
1/15/04 10:33 AM	2.15	1.32	
1/15/04 10:33 AM	2.15	1.32	
1/15/04 10:36 AM	2.00	1.24	

1/27/04 10:15 AM	2.25	1.34	
1/27/04 10:18 AM	2.25	1.76	

Table D-3.3 (continued)

**REDMOND MINI**

Real Time Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)	Field Measurements Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)
10/21/03 12:35 PM	5.08	2.02		10/21/03 12:35 PM	4.88	1.81	
10/21/03 12:36 PM	5.15	2.06		10/21/03 12:37 PM	5.00	1.88	
10/21/03 12:38 PM	5.11	2.02		10/21/03 12:41 PM	5.00	1.81	
11/6/03 12:21 PM	5.01	2.13		11/6/03 12:21 PM	5.00	2.12	
11/6/03 12:24 PM	4.99	2.06		11/6/03 12:24 PM	5.00	2.05	
11/6/03 12:27 PM	5.03	2.06		11/6/03 12:27 PM	5.00	2.03	
11/18/03 1:00 PM	5.40	1.94		11/18/03 1:00 PM	5.50	2.30	
11/18/03 1:05 PM	5.60	2.13		11/18/03 1:05 PM	5.50	2.11	
11/18/03 1:07 PM	5.65	2.06		11/18/03 1:08 PM	5.25	2.11	
12/4/03 10:53 AM	5.27	1.98		12/4/03 10:53 AM	5.25	2.06	
12/4/03 10:56 AM	5.20	1.87		12/4/03 10:56 AM	5.25	1.89	
12/4/03 10:58 AM	5.14	2.09		12/4/03 10:58 AM	5.25	2.06	
12/19/03 10:44 AM	4.77	1.78		12/19/03 10:44 AM	4.75	1.87	
12/19/03 10:48 AM	4.89	1.94		12/19/03 10:48 AM	5.00	1.90	
12/19/03 10:50 AM	4.88	1.94		12/19/03 10:50 AM	5.00	1.85	
12/29/03 9:02 AM	4.59	1.83		12/29/03 9:02 AM	4.50	1.82	
12/29/03 9:03 AM	4.59	1.72		12/29/03 9:03 AM	4.50	1.74	
12/29/03 9:05 AM	4.53	1.65		12/29/03 9:05 AM	4.50	1.66	
1/15/04 10:55 AM	4.98	2.13		1/15/04 10:55 AM	5.00	2.03	
1/15/04 10:57 AM	4.95	1.91		1/15/04 10:57 AM	4.80	2.00	
1/15/04 10:59 AM	4.96	1.87		1/15/04 10:59 AM	4.80	1.90	
1/27/04 10:45 AM	5.02	2.09		1/27/04 10:45 AM	5.00	1.91	
1/27/04 10:46 AM	5.04	2.28		1/27/04 10:46 AM	5.00	2.12	
1/27/04 10:47 AM	4.98	2.24		1/27/04 10:47 AM	5.00	2.15	

Table D-3.3 (continued)

**REDMOND PILOT**

Real Time				Field Measurements			
Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)	Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)
10/21/03 1:20 PM	3.15	1.28		10/21/03 1:15 PM	3.00	1.11	
10/21/03 1:25 PM	3.30	1.37		10/21/03 1:27 PM	3.13	1.09	
10/21/03 1:28 PM	3.37	1.03		10/21/03 1:27 PM	3.13	1.09	
10/21/03 1:28 PM	3.37	1.03		10/21/03 1:30 PM	3.00	1.10	
Meter Pulled							
12/1/03 12:43 PM	3.18	0.54		12/1/03 12:45 PM	3.13	1.19	
12/1/03 12:48 PM	3.18	1.04		12/1/03 12:49 PM	3.13	1.19	
12/1/03 12:50 PM	3.20	1.48		12/1/03 12:52 PM	3.13	1.11	
12/1/03 12:54 PM	3.22	0.60		12/1/03 12:52 PM	3.13	1.11	
12/19/03 11:38 AM	2.89	1.43		12/19/03 11:39 AM	2.88	1.14	
12/19/03 11:42 AM	2.87	1.44		12/19/03 11:43 AM	2.88	1.31	
12/19/03 11:44 AM	3.03	1.46		12/19/03 11:43 AM	2.88	1.31	
12/19/03 11:44 AM	3.03	1.46		12/19/03 11:44 AM	3.00	1.41	
12/29/03 9:46 AM	2.98	0.72		12/29/03 9:46 AM	3.00	0.80	
12/29/03 9:52 AM	2.99	0.99		12/29/03 9:52 AM	5.00	1.00	
12/29/03 9:56 AM	3.10	1.48		12/29/03 9:56 AM	3.25	1.18	
1/15/04 10:03 AM	3.61	0.99		1/15/04 10:03 AM	3.75	1.05	
1/15/04 10:07 AM	3.47	0.94		1/15/04 10:08 AM	3.38	1.13	
1/15/04 10:10 AM	3.27	0.90		1/15/04 10:11 AM	3.25	1.02	
1/27/04 9:53 AM	3.31	0.98		1/27/04 9:53 AM	3.25	0.91	
1/27/04 9:57 AM	3.45	0.79		1/27/04 9:58 AM	3.50	0.85	
1/27/04 10:01 AM	3.44	0.75		1/27/04 10:02 AM	3.50	0.80	
3/8/04 11:54 AM	3.05	0.98		3/8/04 11:54 AM	3.00	1.00	
3/8/04 11:58 AM	3.05	0.89		3/8/04 11:58 AM	3.12	1.00	
3/8/04 12:02 PM	3.20	0.65		3/8/04 12:03 PM	3.25	0.80	
3/8/04 12:07 PM	2.99	0.88					

Table D-3.3 (continued)

**RONALD Control**

Real Time Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)	Field Measurements Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)
10/31/03 2:23 PM	1.09	1.50					
10/31/03 2:28 PM	1.06	1.23		10/31/03 2:28 PM	1.13	1.31	
10/31/03 2:30 PM	0.97	1.23		10/31/03 2:30 PM	1.00	1.20	
10/31/03 2:30 PM	0.97	1.23		10/31/03 2:32 PM	1.00	1.20	
11/6/03 2:31 PM	0.94	1.38		11/6/03 2:31 PM	1.00	1.15	
11/6/03 2:33 PM	1.12	1.76		11/6/03 2:33 PM	1.00	1.62	
11/6/03 2:35 PM	0.99	1.05		11/6/03 2:35 PM	1.00	1.00	
11/19/03 12:56 PM	2.75	4.82		11/19/03 12:56 PM	2.90	4.80	
11/19/03 12:58 PM	2.79	4.56		11/19/03 12:58 PM	2.90	4.69	
11/19/03 1:00 PM	2.78	4.82		11/19/03 1:00 PM	2.90	4.75	
12/5/03 10:31 AM	2.11	2.62		12/5/03 10:31 AM	2.00	2.52	
12/5/03 10:32 AM	2.17	2.62		12/5/03 10:32 AM	2.13	2.57	
12/5/03 10:33 AM	2.15	2.69		12/5/03 10:33 AM	2.13	2.60	
12/16/03 12:26 PM	1.70	1.62		12/16/03 12:29 PM	1.75	1.68	
12/16/03 12:29 PM	1.90	2.02		12/16/03 12:29 PM	1.75	1.68	
12/16/03 12:31 PM	1.82	2.09		12/16/03 12:30 PM	1.88	2.04	
12/16/03 12:31 PM	1.82	2.09		12/16/03 12:31 PM	1.88	2.05	
12/30/03 1:37 PM	1.75	1.87		12/30/03 1:37 PM	1.75	1.68	
12/30/03 1:40 PM	1.75	1.61		12/30/03 1:40 PM	1.75	1.50	
12/30/03 1:42 PM	1.70	1.72		12/30/03 1:42 PM	1.63	1.58	
1/14/04 10:24 AM	2.54	2.63		1/14/04 10:24 AM	2.50	2.47	
1/14/04 10:25 AM	2.48	2.19		1/14/04 10:25 AM	2.50	2.20	
1/14/04 10:26 AM	2.53	2.21		1/14/04 10:26 AM	2.50	2.22	
1/29/04 9:19 AM	3.28	3.33		1/29/04 9:20 AM	3.25	3.20	
1/29/04 9:20 AM	3.13	3.33		1/29/04 9:20 AM	3.25	3.20	
1/29/04 9:21 AM	2.97	3.23		1/29/04 9:21 AM	3.25	3.19	
1/29/04 9:21 AM	2.97	3.23		1/29/04 9:22 AM	3.00	3.15	
2/19/04 12:43 PM	2.65	2.19		2/19/04 12:43 PM	2.60	2.10	
2/19/04 12:46 PM	2.65	2.02		2/19/04 12:46 PM	2.60	2.00	
2/19/04 12:50 PM	2.65	2.00		2/19/04 12:50 PM	2.60	2.00	
2/26/04 2:52 PM	2.29	1.65		2/26/04 2:52 PM	2.00	1.65	
2/26/04 2:58 PM	2.20	1.55		2/26/04 2:58 PM	1.75	1.65	
2/26/04 3:00 PM	2.20	1.50		2/26/04 3:02 PM	2.00	1.55	

Table D-3.3 (continued)

**RONALD PILOT****Real Time**

<b>Date/Time</b>	<b>Depth (in)</b>	<b>Velocity (fps)</b>	<b>Flow (mgd)</b>
10/22/03 1:44 PM	1.71	4.64	
10/22/03 1:49 PM	1.76	4.30	
10/22/03 1:51 PM	1.88	4.60	
11/6/03 2:04 PM	1.70	2.26	
11/6/03 2:07 PM	1.69	3.01	
11/6/03 2:09 PM	1.75	3.03	
11/19/03 1:30 PM	2.78	7.55	
11/19/03 1:33 PM	3.14	7.63	
11/19/03 1:35 PM	3.14	7.89	
12/5/03 10:12 AM	1.85	5.72	
12/5/03 10:13 AM	1.70	5.09	
12/5/03 10:14 AM	1.79	5.39	
12/12/03 9:24 AM	1.95	4.81	
12/12/03 9:26 AM	1.76	4.85	
12/12/03 9:28 AM	1.82	5.56	
12/16/03 12:55 PM	1.87	4.44	
12/16/03 12:57 PM	1.69	4.48	
12/16/03 1:00 PM	1.75	4.17	
12/16/03 1:00 PM	1.75	4.17	
12/30/03 1:07 PM	1.80	4.31	
12/30/03 1:11 PM	1.89	3.80	
12/30/03 1:13 PM	1.82	3.10	
1/9/04 1:31 PM	1.40	4.90	
1/9/04 1:35 PM	1.35	4.96	
1/9/04 1:39 PM	1.39	5.55	
1/14/04 11:06 AM	1.14	3.83	
1/14/04 11:11 AM	1.16	4.78	
1/14/04 11:14 AM	1.16	5.36	
1/29/04 9:42 AM	1.24	4.88	

**Field Measurements**

<b>Date/Time</b>	<b>Depth (in)</b> <b>+/- .13</b>	<b>Velocity (fps)</b>	<b>Flow (mgd)</b>
10/22/03 1:44 PM	1.75	4.47	
10/22/03 1:49 PM	1.75	4.34	
10/22/03 1:51 PM	1.75	4.46	
11/6/03 2:04 PM	1.63	2.15	
11/6/03 2:07 PM	1.63	3.03	
11/6/03 2:09 PM	1.63	3.02	
11/19/03 1:30 PM	2.75	7.23	
11/19/03 1:33 PM	3.00	7.78	
11/19/03 1:35 PM	3.00	7.75	
12/5/03 10:12 AM	2.00	5.68	
12/5/03 10:13 AM	1.88	4.88	
12/5/03 10:14 AM	2.00	5.25	
12/12/03 9:24 AM	2.00	4.69	
12/12/03 9:26 AM	1.88	4.59	
12/12/03 9:28 AM	2.00	5.32	
12/16/03 12:57 PM	1.88	4.54	
12/16/03 12:57 PM	1.88	4.54	
12/16/03 1:00 PM	1.75	4.29	
12/16/03 1:02 PM	1.88	4.09	
12/30/03 1:07 PM	1.75	4.25	
12/30/03 1:11 PM	1.75	3.75	
12/30/03 1:13 PM	1.75	3.14	
1/9/04 1:32 PM	1.38	4.87	
1/9/04 1:36 PM	1.38	4.89	
1/9/04 1:40 PM	1.38	5.45	
1/14/04 11:06 AM	1.13	3.94	
1/14/04 11:11 AM	1.13	4.79	
1/14/04 11:15 AM	1.13	4.84	
1/29/04 9:43 AM	1.25	4.23	

Table D-3.3 (continued)

**RONALD PILOT****Real Time**

<b>Date/Time</b>	<b>Depth (in)</b>	<b>Velocity (fps)</b>	<b>Flow (mgd)</b>
1/29/04 9:47 AM	1.30	4.63	
1/29/04 9:51 AM	1.29	5.46	
2/19/04 1:13 PM	0.97	4.18	
2/19/04 1:17 PM	0.99	4.13	
2/19/04 1:20 PM	1.00	4.11	
2/26/04 2:26 PM	0.88	2.88	
2/26/04 2:36 PM	0.98	4.38	
2/26/04 2:38 PM	0.97	3.82	

**Field Measurements**

<b>Date/Time</b>	<b>Depth (in)</b> <b>+/- .13</b>	<b>Velocity (fps)</b>	<b>Flow (mgd)</b>
1/29/04 9:48 AM	1.25	4.50	
1/29/04 9:52 AM	1.25	4.36	
2/19/04 1:13 PM	1.00	4.05	
2/19/04 1:17 PM	1.00	4.10	
2/19/04 1:20 PM	1.00	4.05	
2/26/04 2:27 PM	1	2.78	
2/26/04 2:36 PM	1	4.15	
2/26/04 2:38 PM	1	3.5	

Table D-3.3 (continued)

**SKYWAY CONTROL**

Real Time Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)	Field Measurements Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)
10/6/03 11:52 AM	0.75	2.21		10/6/03 11:52 AM	0.75		
10/6/03 11:58 AM	0.79	2.33					
				10/6/03 12:10 PM	0.75		
				10/6/03 12:12 PM			
				10/6/03 12:14 PM			
10/6/03 12:20 AM	0.93	2.44		10/6/03 12:20 PM	1.00		
10/6/03 12:24 AM	0.90	2.38					
11/4/03 12:59 PM	1.10	2.42		11/4/03 12:58 PM	0.75	2.10	
11/4/03 12:59 PM	1.10	2.42		11/4/03 12:59 PM	0.78	2.02	
11/4/03 1:03 PM	1.02	2.38		11/4/03 1:03 PM	1.00	2.36	
11/4/03 1:05 PM	0.95	2.27		11/4/03 1:03 PM	1.00	2.36	
11/18/03 9:22 AM	5.48	4.97		11/18/03 9:23 AM	5.33	5.60	
11/18/03 9:25 AM	5.57	5.07		11/18/03 9:26 AM	5.40	5.60	
11/18/03 9:29 AM	5.53	4.71		11/18/03 9:31 AM	5.40	5.66	
12/2/03 10:19 AM	1.29	2.79		12/2/03 10:20 AM	1.38	2.78	
12/2/03 10:23 AM	1.33	2.66		12/2/03 10:24 AM	1.38	2.75	
12/2/03 10:26 AM	1.45	2.55		12/2/03 10:27 AM	1.38	2.48	
12/17/03 11:47 AM	1.27	2.73		12/17/03 11:47 AM	1.25	2.64	
12/17/03 11:51 AM	1.26	2.59		12/17/03 11:51 AM	1.25	2.45	
12/17/03 11:53 AM	1.26	2.51		12/17/03 11:53 AM	1.25	2.60	
12/29/03 10:07 AM	1.63	2.73		12/29/03 10:07 AM	1.60	2.60	
12/29/03 10:12 AM	1.26	2.79		12/29/03 10:12 AM	1.25	2.60	
12/29/03 10:15 AM	1.37	2.85		12/29/03 10:15 AM	1.40	2.80	
1/13/04 1:43 PM	1.54	2.92		1/13/04 1:43 PM	1.50	3.07	
1/13/04 1:48 PM	1.45	2.76		1/13/04 1:48 PM	1.50	2.66	
1/13/04 1:50 PM	1.42	3.05		1/13/04 1:50 PM	1.38	3.02	
1/27/04 9:56 AM	1.33	2.82	0.07	1/27/04 9:59 AM	1.25	2.90	
1/27/04 10:01 AM	1.33	2.70	0.07	1/27/04 10:03 AM	1.30	2.80	
1/27/04 10:05 AM	1.30	2.64	0.06	1/27/04 10:07 AM	1.33	2.75	

Table D-3.3 (continued)

**SKYWAY PILOT**

<b>Real Time</b>				<b>Field Measurements</b>			
<b>Date/Time</b>	<b>Depth (in)</b>	<b>Velocity (fps)</b>	<b>Flow (mgd)</b>	<b>Date/Time</b>	<b>Depth (in)</b>	<b>Velocity (fps)</b>	<b>Flow (mgd)</b>
10/9/03 11:31 AM	0.33	5.37	16475.5	10/9/03 11:31 AM	0.38		
				10/9/03 11:44 AM			
10/9/03 11:45 AM	0.23	4.93		10/9/03 11:45 AM	0.25		
10/9/03 11:47 AM	0.23	4.53		10/9/03 11:45 AM	0.25		
10/9/03 11:47 AM	0.23	4.53		10/9/03 11:48 AM	0.38		
11/4/03 12:27 PM	0.18	5.72					
11/4/03 12:31 PM	0.28	5.61		11/4/03 12:33 PM	0.38	5.31	
11/4/03 12:36 PM	0.15	4.96		11/4/03 12:36 PM	0.30	4.82	
11/4/03 12:38 PM	0.23	5.05		11/4/03 12:39 PM	0.25	4.75	
11/18/03 8:49 AM	0.65	8.10		11/18/03 8:50 AM	0.69	8.20	
11/18/03 8:53 AM	0.74	8.49		11/18/03 8:54 AM	0.50	8.44	
11/18/03 8:59 AM	0.79	8.52		11/18/03 8:59 AM	0.90	8.00	
12/2/03 9:45 AM	0.47	6.28		12/2/03 9:46 AM	0.60	6.45	
12/2/03 9:51 AM	0.99	6.93		12/2/03 9:52 AM	1.00	6.88	
12/2/03 9:55 AM	0.67	6.39		12/2/03 9:56 AM	0.75	5.86	
12/17/03 11:27 AM	0.47	6.15		12/17/03 11:27 AM	0.50	5.94	
12/17/03 11:31 AM	0.53	6.09		12/17/03 11:31 AM	0.75	5.71	
12/17/03 11:34 AM	0.54	6.21		12/17/03 11:34 AM	0.50	5.80	
12/29/03 9:41 AM	0.38	5.2		12/29/03 9:42 AM	0.40	5.75	
12/29/03 9:46 AM	0.52	6.88		12/29/03 9:47 AM	0.60	6.75	
12/29/03 9:50 AM	0.44	6.56		12/29/03 9:50 AM	0.50	6.50	
1/13/04 1:12 PM	0.61	6.59		1/13/04 1:12 PM	0.68	5.76	
1/13/04 1:18 PM	Level cal			1/13/04 1:17 PM	Level cal		
1/13/04 1:23 PM	0.77	6.75		1/13/04 1:23 PM	0.68	5.01	
1/13/04 1:28 PM	0.82	6.41		1/13/04 1:28 PM	0.90	5.99	
1/27/04 9:11 AM	0.61	5.83	0.04	1/27/04 9:18 AM	0.63	5.70	
1/27/04 9:20 AM	0.57	6.00	0.04	1/27/04 9:25 AM	0.60	6.10	
1/27/04 9:27 AM	0.57	6.26	0.04	1/27/04 9:30 AM	0.60	5.80	

Table D-3.3 (continued)

**VALVUE Control****Real Time**

<b>Date/Time</b>	<b>Depth (in)</b>	<b>Velocity (fps)</b>	<b>Flow (mgd)</b>
10/31/03 9:20 AM	0.88	10.66	
10/31/03 9:35 AM	0.76	10.10	
10/31/03 9:36 AM	0.87	10.17	
11/6/03 9:37 AM	0.73	7.93	
11/6/03 9:39 AM	0.79	8.08	
11/6/03 9:41 AM	0.83	8.68	
11/17/03 9:28 AM	0.85	9.54	
11/17/03 9:29 AM	0.75	8.90	
11/17/03 9:31 AM	0.77	10.32	
12/17/03 12:43 PM	0.92	9.91	
12/17/03 12:47 PM	0.83	9.32	
12/17/03 12:48 PM	0.83	9.22	
12/29/03 10:50 AM	1.00	11.00	
12/29/03 10:52 AM	0.99	10.97	
12/29/03 10:54 AM	0.99	10.75	
1/15/04 10:50 AM		11.58	
1/15/04 10:51 AM		11.57	
1/15/04 10:53 AM		11.58	

**Field Measurements**

<b>Date/Time</b>	<b>Depth (in)</b>	<b>Velocity (fps)</b>	<b>Flow (mgd)</b>
10/31/03 9:20 AM	1.00	9.00	
10/31/03 9:35 AM	1.00	10.00	
10/31/03 9:36 AM	1.00	9.90	
11/6/03 9:37 AM	0.75	8.15	
11/6/03 9:39 AM	0.75	8.01	
11/6/03 9:41 AM	0.88	7.47	
11/17/03 9:28 AM	0.88	10.10	
11/17/03 9:29 AM	0.88	7.86	
11/17/03 9:31 AM	0.88	10.01	
12/17/03 12:43 PM	1.00	9.89	
12/17/03 12:47 PM	1.00	9.25	
12/17/03 12:48 PM	1.00	9.25	
12/29/03 10:50 AM	1.00	10.90	
12/29/03 10:52 AM	1.00	10.90	
12/29/03 10:54 AM	1.00	10.90	
1/15/04 10:50 AM		11.30	
1/15/04 10:51 AM		11.38	
1/15/04 10:53 AM		11.50	

Table D-3.3 (continued)

**VALVUE PILOT**

Real Time				Field Measurements			
Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)	Date/Time	Depth (in)	Velocity (fps)	Flow (mgd)
10/22/03 10:50 AM	1.45	1.27		10/22/03 10:50 AM	1.38	1.29	
10/22/03 10:53 AM	1.52	1.76		10/22/03 10:53 AM	1.30	1.74	
10/22/03 10:59 AM	1.48	1.46		10/22/03 10:59 AM	1.50	1.33	
11/6/03 9:00 AM	0.92	0.75		11/6/03 9:00 AM	0.88		
11/6/03 9:02 AM	1.12	0.71		11/6/03 9:02 AM	1.00		
11/6/03 9:05 AM	1.23	0.86		11/6/03 9:05 AM	1.25		
11/17/03 9:13 AM	1.06	0.52		11/17/03 9:14 AM	1.00	0.54	
11/17/03 9:16 AM	0.95	0.67		11/17/03 9:16 AM	1.00	0.58	
11/17/03 9:17 AM	0.99	0.90		11/17/03 9:18 AM	1.00	0.81	
12/2/03 11:05 AM	1.46	1.38		12/2/03 11:05 AM	1.40	1.33	
12/2/03 11:15 AM	1.36	1.87		12/2/03 11:15 AM	1.38	1.74	
12/2/03 11:17 AM	1.41	1.68		12/2/03 11:17 AM	1.40	1.83	
12/17/03 12:30 PM	1.11	0.40		12/17/03 12:30 PM	1.00	0.40	
12/17/03 12:33 PM	1.12	0.41		12/17/03 12:33 PM	1.00	0.33	
12/17/03 12:35 PM	1.10	0.40		12/17/03 12:35 PM	1.00	0.35	
12/29/03 12:58 PM	4.38	4.38		12/29/03 12:58 PM	3.75	3.66	
12/29/03 1:00 PM	3.66	3.63		12/29/03 1:00 PM	3.53	3.66	
12/29/03 1:02 PM	2.28	3.33		12/29/03 1:02 PM	2.15	3.20	
1/15/04 10:12 AM	6.10	3.50		1/15/04 10:12 AM	5.90	3.40	
1/15/04 10:15 AM	5.00	2.87		1/15/04 10:15 AM	5.25	2.50	
1/15/04 10:20 AM	1.87	1.42		1/15/04 10:20 AM	2.00	1.50	
1/27/04 11:15 AM	1.48	0.34		1/27/04 11:19 AM	1.00	0.35	
1/27/04 11:21 AM	1.47	0.37		1/27/04 11:23 AM	1.13	0.45	
1/27/04 11:24 AM	1.55	0.47		1/27/04 11:23 AM	1.13	0.45	
1/27/04 11:24 AM	1.55	0.47		1/27/04 11:25 AM	1.00	0.45	

**Table D - 4.1 Data adjustment summary for the Pre-rehabilitation monitoring period (2002/2003)**

Site Name	Comments*
Auburn Control	No significant data adjustment
Auburn Pilot	No significant data adjustment
Auburn Subtraction	No significant data adjustment
Brier Control	Velocity multiplier was modified and flow was recalculated using the modified multiplier. Based on upstream and downstream flow imbalance, the flow data at the Brier Control site was reviewed. The raw FFT (velocity spectrum) and data files were sent to Marsh McBirney technical staff for further analysis. Velocity multipliers (used by the meter algorithm to convert surface velocity to average velocity) were extracted giving an average value of 1.13. This high value and the high % relative deviation of velocity field verifications indicated that the FFT algorithm may be wrong. Further review showed that, due to poor hydraulics, the FFT was consistently picking up the higher values of the double hump velocity spectrums (representing both the surface velocity and the velocity of the waves moving across the surface). Based on the observation that the meter was reading high and that it was picking on the "high" side, surface to average velocity ratios were extracted from the lower humps and a velocity multiplier of 0.84 was estimated for this site. Even though this is not the preferred method of adjusting the velocity multiplier ("GAIN" in ADS meters), it is the best estimate in the absence of a complete profile. Due to the low flow condition, no velocity profile was done at this site.
Brier Pilot	No significant data adjustment
Kent Control	No significant data adjustment
Kent Pilot A	data gap - inconsistent data deleted
Kent Pilot B	No significant data adjustment
Kirkland Control	Velocity multiplier (used to convert surface to average velocity) was modified based on field verifications and flow was recalculated using the modified multiplier. The method and approach used are similar to the one used for Brier Control (see above)
Kirkland Pilot	No significant data adjustment
Mercer Control	No significant data adjustment
Mercer Mini	Velocity snapped - Velocity sensor not functioning properly after 3/26; velocity reconstituted 3/27 through 4/20/03 based on previous good depth-velocity relationships
Mercer Pilot	Some poor depth data flagged; Velocity drops to zero during early morning hours reconstituted (snapped to curve)
Redmond Control	No significant data adjustment
Redmond Mini	No significant data adjustment
Redmond Pilot	Due to the data loss experienced at this site, the sensor was replaced on 2/5/03. The velocity pattern prior to 2/25/03 was spiky and the diurnal pattern was not well defined. After the sensor swap, velocity pattern matched that of depth and the diurnal pattern was well defined. Depth pattern remained the same before and after the sensor swap. Velocity data prior to 2/5/03 is snapped to curve based on depth-velocity relationship after 2/5/03. Velocity drops to zero during early morning hours are snapped to curve
Skyway Control	No significant data adjustment
Skyway Pilot	No significant data adjustment

\* = No significant data adjustment indicates differences between the RAW and EDITED data were less than 10%. Where the difference is > 10%, summary of the reason for the difference is provided. The difference between the two data sets include depth and/or velocity adjustments based on field verification, and data gaps where depth and/or velocity data have been edited/flagged.

Table D - 4.2 Data adjustment summary for the Post-rehabilitation monitoring period (2003/2004)

Site Name	Comments*
Auburn Control	No significant data adjustment
Auburn Pilot	No significant data adjustment
Auburn Subtraction	No significant data adjustment
Brier Control	Velocity drops to zero snapped to curve; Velocity multiplier changed from 1 to 0.84 based on velocity profiling. Level Cal changed - The level calibration allows one to adjust the calibration in the level measurement system. Calibrating the level helps obtain maximum accuracy from the flow meter.
Brier Pilot	Based on field verifications, depth was adjusted by 0.13 inches from 1/8 to 1/23/04.
Coal Creek Control	No significant data adjustment
Coal Creek Pilot	No significant data adjustment
Kent Control	No significant data adjustment
Kent Pilot A	Depth sensor malfunctioned and was replaced on 2/2/04; depth data from 1/30/04 6:20 PM to 2/2/04 12:10 PM reconstructed using depth-velocity relationship before 1/30/04; data after 2/11/04 was collected using a level cal of 0.35 inches. These depth data have been adjusted by -0.35 inches to reflect the final level cal of 0.0 inches. In addition, depth data from 2/11 to 2/17/04 have been adjusted by -0.13 inches (margin of error for the field measurements ) to match the data after 2/17/04
Kent Pilot B	The 2/17/04 field log indicates that the sensor cable was in the flow (at the time of visit) causing a slight back up. Sensor cables in the flow may also interfere with the ultrasonic level sensor signal and affect the depth measurement. The depth data from 2/11/04 9:50 AM to 2/17/04 12 PM appears to be off by 0.5 to 1 inch compared to the historical data (before 2/11/04 and after 2/17/04).
Kirkland Control	Velocity multiplier changed based on field verification/observation; some velocity reconstituted (snapped)
Kirkland Pilot	Velocity drops snapped
Lake Forest Park Control	No significant data adjustment
Lake Forest Park Pilot	Erroneous depth data flagged
Mercer Control	No significant data adjustment
Mercer Mini	No significant data adjustment
Mercer Pilot	No significant data adjustment
North Shore Control	No significant data adjustment
North Shore Pilot	Velocity drops snapped
Redmond Control	Velocity drops snapped
Redmond Mini	No significant data adjustment
Redmond Pilot	No significant data adjustment
Ronald Control	Ultrasonic sensor was swapped on 1/14/04; The electronic offset was not adjusted properly when swapping the sensor and the depth is adjusted by 1/2 inch (after 1/14/04) to reflect the change due to the improper electronic offset adjustment; field verifications on 1/14/04 indicate that the meter was off by about 0.5 inches

Table D - 4.2 Data adjustment summary for the Post-rehabilitation monitoring period (2003/2004)

Site Name	Comments*
<b>Ronald Pilot</b>	The original meter produced poor depth and spiky velocity - slight increase in depth was causing the flow to spray off of the sensor/ring assembly and splash on to the ultrasonic sensor (mounted at the crown of the pipe) giving erroneous depth data; Due to unreliable depth data during slightly elevated depths of flow, the meter was replaced with a Flo-Dar unit. The Flo-Dar unit produced good depth and velocity data; Based on field verifications and consistency with the Flo-Dar unit, data from the ADS meter was adjusted by -0.13 inches. Depth ranges from about 1 to 3 inches; velocity ranges 1 to 6 fps; some erroneous velocity and significant amount of depth data flagged
<b>Skyway Control</b>	Velocity multiplier changed based on field verification/observation
<b>Skyway Pilot</b>	Based on field verifications, the depth data was adjusted by 0.17 inches (level cal =0.17 on 1/13/04 verification). During install (10/9/03) it was noted that the incoming pipe (to the manhole) was offset. The field crew realigned the sensor on 11/4 to compensate for the pipe offset (Earth Tech visited the site on 11/7 to check the meter placement and the pipe offset). The depth data from 10/9 to 11/5/03 was reconstructed based on the data after realignment. erroneous velocity and depth data edited;
<b>Val Vue Control</b>	No significant data adjustment
<b>Val Vue Pilot</b>	No significant data adjustment

\* = No significant data adjustment indicates differences between the RAW and EDITED data were less than 10%. Where the difference is > 10%, summary of the reason for the difference is provided. The difference between the two data sets include depth and/or velocity adjustments based on field verification, and data gaps where depth and/or velocity data have been edited/flagged.

**Table D-5.1a - Data Quality Rating**

Data Quality Rating	
Rating	Criteria
Good	Minimal to moderate data loss; depth and velocity diurnal patterns matching and consistent with site hydraulics; routine editing performed to flag pops and drops in the data not consistent with the site hydraulics
Fair	Moderate to significant data loss; depth and velocity diurnal patterns matching and consistent with site hydraulics; depth and/or velocity problems identified, and editing performed to flag erroneous data; some data reconstitution performed
Poor	Significant to extensive data loss; depth and velocity diurnal patterns may or may not be matching and in some instances may not be consistent with site hydraulics; Significant amount of data editing and/or reconstitution performed.

**Table D-5.1b - Data Loss Rating**

Data Loss Rating	
Rating	Criteria
Minimal	> 95% Uptime
Moderate	90 - 95% Uptime
Significant	80 - < 90% Uptime
Extensive	< 80% Uptime

**Table D - 5.2 Pre-rehabilitation monitoring period final data review summary and comments on data quality and data gaps**

Site Name	Data Quality*	Data loss**	Data Review
Auburn Control	Good	Minimal	Good depth and velocity data; patterns match with velocity increasing as depth increased; Depth ranges from about 2 inches to full pipe and velocity from less than 1 fps to about 3-1/2 fps; velocity occasionally drops to zero; zero velocities not edited; depth on few occasions flatlined at about 8 inches indicating a surcharged condition. As the pressure sensor wasn't functional the depth of flow above full pipe (height) is not determined but assumed to be at least 10 inches (full pipe). Depth and velocity patterns indicate pump station influenced flow; site responds to rain events (increased depth and velocity)
Auburn Pilot	Good	Minimal	Good depth and velocity data; patterns match with velocity increasing as depth increased; Depth ranges from about 1-1/2 inches to full pipe and velocity from less than 1 fps to about 4 fps; velocity occasionally drops to zero; zero velocities not edited; depth on few occasions flatlined at about 8 inches indicating a surcharged condition. As the pressure sensor wasn't functional the depth of flow above full pipe (height) is not determined but assumed to be at least 10 inches (full pipe). Depth and velocity patterns indicate pump station influenced flow; probable surcharge conditions observed; site responds to rain events (increased depth and velocity); slight back water conditions (above 6.5 inches of depth of flow) observed
Auburn Subtraction	Good	Moderate	Good depth and velocity data; patterns match with velocity increasing as depth increased; Depth ranges from about 1-1/2 inches to about 3 inches and velocity from less than 1 fps to about 6 fps; velocity occasionally drops to zero; zero velocities not edited; Shallow and fast flow; Depth and velocity patterns indicate pump station influenced flow; site responds to rain events
Brier Control	Poor to fair	Significant	Good depth data; velocity data poor to fair; some velocity data reconstructed and depth data flagged; Depth ranges from about 1.5 to 5.5 inches and velocity from < 1 fps to about 3 fps; Poor hydraulics - very dirty line- debris accumulate and block flow temporarily creating back water conditions at shallow depths (2 to 3 inches) and distorting the velocity profile (where the radar beam hits the flow and senses the velocity); site responds to rain events (increased depth and velocity); <b>Velocity multiplier (to convert surface to average velocity) was modified based on field verifications</b>
Brier Pilot	Good	Minimal	Good depth and velocity data; patterns match with velocity increasing as depth increased; Depth ranges from about 1.5 inches to 7 inches and velocity from < 1 fps to about 3 1/2 fps; some poor depth data flagged; depth and velocity patterns changed (increased) 3/22 - 4/16/03; good hydraulics - open channel flow; site responds to rain events (increased depth and velocity); <b>Velocity Gain (to convert Peak to average velocity) was modified based on field verifications.</b>
Coal Creek Control	N/A	N/A	N/A
Coal Creek Pilot	N/A	N/A	N/A
Kent Control	Good	Minimal	Good depth and velocity data; patterns match with velocity increasing as depth increased; Depth ranges from about 0.5 inches to 1.5 inches and velocity from 1 fps to about 3 fps; some poor velocity data reconstructed; good hydraulics - open channel flow; site responds to rain events (increased depth and velocity)
Kent Pilot A	Good	Minimal	Good depth and velocity data; patterns match with velocity increasing as depth increased; shallow and fast flow - Depth ranges from about 1 to 2 inches and velocity from 2 to about 8 fps; few erroneous depth data flagged; good hydraulics - open channel flow; site responds to rain events (increased depth and velocity)
Kent Pilot B	Fair	Moderate	Good depth and fair velocity data; patterns match with velocity increasing as depth increased during open channel flow conditions and velocity dropping while depth increased during back water conditions ; Depth ranges from about 1.5 to 3 inches and velocity from < 1 fps to about 3 fps; some poor velocity data edited; poor to good hydraulics - mostly open channel flow but site goes in to back water conditions occasionally; very dirty line- debris accumulate and block flow temporarily creating back water conditions at shallow depths (2 to 3 inches) and distorting the velocity profile (where the radar beam hits the flow and senses the velocity); site responds to rain events (increased depth and velocity)
Kirkland Control	Good	Minimal	Good depth and velocity data; patterns match with velocity increasing as depth increased; Depth ranges from about 2.5 to 5 inches and velocity from < 1 fps to about 3 fps; good hydraulics - open channel flow; site responds to rain events (increased depth and velocity); <b>Velocity multiplier (to convert surface to average velocity) was modified based on field verifications</b>

**Table D - 5.2 Pre-rehabilitation monitoring period final data review summary and comments on data quality and data gaps**

Site Name	<a href="#">Data Quality*</a>	<a href="#">Data loss**</a>	Data Review
Kirkland Pilot	Good	Minimal	Good depth and velocity data; patterns match with velocity increasing as depth increased; Depth ranges from about 2 inches to 6.5 inches and velocity from < 1 fps to about 1-1/2 fps; Flow is relatively deep and slow; Site exhibited two-three patterns during this monitoring period. 11/17 to 11/19 and 11/29 to 12/12, the site hydraulics shifted to a deeper and slower pattern; the hydraulic shift may have been caused by a temporary blockage downstream of the monitoring site; significant response to rain events
Lake Forest Park Control	N/A	N/A	N/A
Lake Forest Park Pilot	N/A	N/A	N/A
Mercer Control	Good	Minimal	Good depth and velocity data; patterns match with velocity increasing as depth increased; Shallow and fast flow - depth ranges from about 0.5 to 2 inches and velocity from 2 to about 8 fps; good hydraulics - open channel flow; site responds to rain events (increased depth and velocity)
Mercer Mini	Fair	Minimal	Good depth and velocity data; patterns match with velocity increasing as depth increased; Depth ranges from about 1 to 3.5 inches and velocity from about 1 to 6 fps; erroneous depth and velocity spikes are flagged; <b>velocity sensor not functioning properly after 3/26; velocity reconstituted 3/27 through 4/20/03 based on previous good depth-velocity relationships</b> ; Good hydraulics - open channel flow up to about 3 1/2 inches of flow; site surcharges at shallow depths (above 3.5 inches) due to blockage downstream (the D/S MH (30090) has a plate baffle mounted on it's discharge side to prevent clogging of the Lake Line) - a flow test on 3/19/03 has confirmed this; site responds to rain events (increased depth and velocity)
Mercer Pilot	Fair	Significant	Good depth and velocity data; patterns match with velocity increasing as depth increased; Depth ranges from about 0.5 to 3 inches and velocity from 0.5 to about 2.5 fps; some poor depth data flagged; velocity drops to zero during early morning hours; velocity drops reconstituted (snapped to curve); good hydraulics - relatively shallow and slow open channel flow; site responds to rain events (increased depth and velocity)
North Shore Control	N/A	N/A	N/A
North Shore Pilot	N/A	N/A	N/A
Redmond Control	Fair to Good	Minimal	Good depth and velocity data; patterns match with velocity increasing as depth increased; Depth ranges from about 1 to 4 inches and velocity from < 1 to about 2 fps; erroneous depth and velocity data edited; velocity drops during early morning hours snapped to curve (reconstituted); good hydraulics - open channel flow; site responds to rain events (increased depth and velocity)
<a href="#">Redmond Mini</a>	Good	Minimal	Good depth and velocity data; diurnal patterns with mostly velocity increasing as depth increased; Depth ranges from about 5 inches to 9 inches and velocity mostly < 2 fps; some poor velocity data flagged; Slow and moderately deep flow; site slightly responds to rain events and exhibits three patterns - (1) open channel flow - example 12/17 - 12/23/02 (2) back water conditions above approximately 5 inches of flow - example 1/4 to 1/6/03 and (3) hydraulic shift to a deeper and slower pattern - example 2/18 - 2/24/03. The hydraulic shift is believed to have been caused by temporary blockage from debris accumulating downstream of the monitoring point. Cobble to boulder sized debris have been observed in the pipe one manhole downstream of this monitoring manhole. There has been a sink hole repair construction in a line that enters the system downstream of the Redmond Mini monitoring site. It appears that pieces of debris from the construction activity may have been dislodged and deposited in to the line downstream creating temporary blockage ( <a href="#">click</a>
Redmond Pilot	Poor to fair	Extensive	Good depth and velocity data; patterns match with velocity increasing as depth increased; Depth ranges from about 1 to 6.5 inches and velocity from < 1 to about 3 fps; <b>Due to the data loss, the sensor was replaced on 2/5/03. The velocity pattern prior to 2/25/03 was spiky and the diurnal pattern was not well defined. After the sensor swap, velocity pattern matched that of depth and the diurnal pattern was well defined.</b> Depth pattern remained the same before and after the sensor swap. <b>Velocity data prior to 2/5/03 is snapped to curve based on depth-velocity relationship after 2/5/03.</b> Velocity drops to zero during early morning hours. These velocity data are snapped to curve. good hydraulics - open channel flow; even though most of the data loss occurred during rain events, this site appears to respond to rain events (increased depth and velocity)
Ronald Control	N/A	N/A	N/A
Ronald Pilot	N/A	N/A	N/A

**Table D - 5.2 Pre-rehabilitation monitoring period final data review summary and comments on data quality and data gaps**

Site Name	<a href="#">Data Quality*</a>	<a href="#">Data loss**</a>	Data Review
Skyway Control	Fair to Good	Moderate	Good depth and velocity data; patterns match with velocity increasing as depth increased; Fast and shallow flow ( mostly < 2 inches except during rain events); Depth ranges from < 1 to about 6 inches and velocity from about 1 to about 5 fps; velocity quality dropped slightly after 1/2/03 especially during and after rain events; some velocity data is reconstituted; good hydraulics - open channel flow; site exhibits two patterns - during rain events and at other times (no rain); site responds to rain events (increased depth and velocity)
Skyway Pilot	Good	Minimal	Good depth and velocity data; patterns match with velocity increasing as depth increased; Fast and shallow flow (< 2 inches except during rain events) - depth ranges from about 0.5 to 3.5 inches and velocity from 3 to about 10 fps; good hydraulics - open channel flow; site responds to rain events (increased depth and velocity)
Val Vue Control	N/A	N/A	N/A
Val Vue Pilot	N/A	N/A	N/A

N/A = Not monitored during the 2002/2003 pre-rehabilitation monitoring period

\*, \*\* = qualitative ratings set by King County- click on links for details; \*\* = Data gap periods are listed in Appendix D Table D-2.1

**Table D - 5.3 Post-rehabilitation monitoring period final data review summary and comments on data quality and data gaps**

Site Name	Data Quality*	Data loss**	Data review
Auburn Control	Fair to Good	Minimal	Good depth and velocity data; patterns match with velocity increasing as depth increased; Depth ranges from about 2 inches to full pipe and velocity from less than 1 fps to about 4-1/2 fps; some velocity drops snapped to curve and erroneous velocity and depth data flagged; depth on few occasions flatlined at about full pipe indicating a surcharged condition. Pressure sensor depth used instead of ultrasonic depth during surcharge periods. Velocity sensor replaced 12/18/03. Depth and velocity patterns indicate pump station influenced flow; surcharge conditions observed (10/20/03 to 11.5 inches); site responds to rain events (increased depth and velocity).
Auburn Pilot	Fair to Good	Minimal	Good depth and velocity data; patterns match with velocity increasing as depth increased; Depth ranges from about 2 inches to 30 inches (during surcharge on 11/18 - 11/19/03) and velocity from about 1 fps to about 3.5 fps; some velocity drops snapped to curve and erroneous velocity and depth data flagged; surcharged conditions observed 11/18/03, 11/19/03, and 1/29/04 (to about 18 inches). Depth on few occasions flatlined at about full pipe indicating surcharged conditions. Pressure sensor depth used instead of ultrasonic depth during surcharge periods. Depth and velocity patterns indicate pump station influenced flow; site responds to rain events (increased depth and velocity).
Auburn Subtraction	Fair to Good	Moderate	Good depth and velocity data; patterns match with velocity increasing as depth increased; Depth ranges from about 1/4 inches to 3 inches and velocity from about 1/2 fps to about 6 fps; some velocity drops snapped to curve and erroneous velocity and depth data edited; Depth and velocity patterns indicate pump station influenced flow; site responds to rain events (increased depth and velocity), but no surcharge observed.
Brier Control	Fair to Good	Minimal	Good depth and velocity data; patterns match with velocity increasing as depth increased; Depth ranges from about 3 inches to 6 inches and velocity from about 1/2 fps to about 1-1/2 fps; some velocity drops snapped to curve and erroneous velocity and depth data edited; fair to good hydraulics - moderately deep and slow flow; site responds to rain events (increased depth and velocity), but did not surcharge; Velocity multiplier changed to from 1 to 0.84 based on velocity profiling. Level Cal changed
Brier Pilot	Fair to Good	Minimal	Good depth and velocity data; patterns match with velocity increasing as depth increased; Depth ranges from about 1.5 inches to 3.5 inches and velocity from about 1 fps to about 4-1/2 fps; good hydraulics - shallow and moderately fast open channel flow; site responds to rain events (increased depth and velocity) some velocity drops snapped to curve and erroneous velocity and depth data flagged; Based on field verifications, depth was adjusted by 0.13 inches from 1/8 to 1/23/04.
Coal Creek Control	Good	Minimal	Good depth and velocity data; patterns match with velocity increasing as depth increased; Depth ranges from 1 to 6 inches and velocity from about 1/2 fps to about 2-1/2 fps; good hydraulics - shallow and slow open channel flow; site responds to rain events (increased depth and velocity) minimal data editing done.
Coal Creek Pilot	Fair to Good	Minimal	Good velocity data; Poor depth data; patterns match with velocity increasing as depth increased; Depth ranges from about 2.5 to 4 inches (mostly) and velocity from about 1 fps to about 2-1/2 fps; erroneous velocity and depth data flagged; fair hydraulics - moderately deep and slow open channel flow; site responds to rain events (increased depth and velocity) minimal data editing done. Pressure depth used 1/29 - 1/30/04. No surcharge was observed.
Kent Control	Good	Minimal	Good depth and velocity data; patterns match with velocity increasing as depth increased; Depth ranges from about 1/2 inches to 2-1/2 inches and velocity from about 1-1/2 fps to about 3-1/2 fps; erroneous velocity and depth data edited (minimal data editing done); fair to good hydraulics - shallow and slow flow; site responds to rain events (increased depth and velocity), but did not surcharge

**Table D - 5.3 Post-rehabilitation monitoring period final data review summary and comments on data quality and data gaps**

Site Name	Data Quality*	Data loss**	Data review
Kent Pilot A	Fair to Good	Significant	Good depth and velocity data; patterns match with velocity increasing as depth increased; Depth is less than 1 inches and velocity ranges from about 1-1/2 fps to about 5-1/2 fps; erroneous velocity and depth data edited ; fair to good hydraulics - shallow and fast flow; slight response to the 1/29 - 1/30/04 rain event (increased depth and velocity), but did not surcharge. Depth sensor malfunctioned and was replaced on 2/2/04; depth data from 1/30/04 6:20 PM to 2/2/04 12:10 PM reconstructed using depth-velocity relationship before 1/30/04; data after 2/11/04 was collected using a level cal of 0.35 inches. These depth data have been adjusted by -0.35 inches to reflect the final level cal of 0.0 inches. In addition, depth data from 2/11 to 2/17/04 has been adjusted by -0.13 inches (margin of error for the field measurements ) to match the data after 2/17/04 - use this portion of the data with caution.
Kent Pilot B	Poor to Fair	Significant	Poor to fair depth and velocity data; Depth ranges from 1/2 to 2 inches and velocity from about 1/2 fps to about 2-1/2 fps; erroneous velocity and depth data edited ; poor to fair hydraulics - shallow and slow; site exhibits alternating open channel flow and back water conditions ; dirty line - debris accumulate and block flow temporarily creating back water conditions even at shallow depths (< 2 inches) distorting the depth-velocity profile; slight response to the 1/29 - 1/30/04 rain event; the 2/17/04 field log indicates that the sensor cable was in the flow (at the time of visit) causing a slight back up. Sensor cables in the flow may also interfere with the ultrasonic level sensor signal and affect the depth measurement. The depth data from 2/11/04 9:50 AM to 2/17/04 12 PM appears to be off by 0.5 to 1 inch compared to the historical data (before 2/11/04 and after 2/17/04). These portion of the data have been adjusted, but should be used cautiously.
Kirkland Control	Fair to Good	Minimal	Good depth and velocity data; Depth ranges from 2 to 6 inches and velocity from about 1 fps to about 2-1/2 fps; erroneous velocity and depth data edited; some velocity data reconstructed ; Velocity multiplier changed; good hydraulics - moderately deep and slow; site responds to rain events, but didn't surcharge
Kirkland Pilot	Fair to Good	Minimal	Good depth data; Poor velocity data during early morning hours (drops to zero); patterns match with velocity increasing as depth increased; Depth ranges from about 3 to 10 inches (during rain storms) and velocity from about 1/2 fps to about 1-1/2 fps; erroneous velocity and depth data flagged; velocity drops snapped to curve; fair to good hydraulics - moderately deep and slow open channel flow; site responds to rain events (increased depth and velocity). Two patterns observed - flow became deeper and slower after 10/17/03. No surcharge was observed.
Lake Forest Park Control	Fair to Good	Minimal	Good depth and velocity data; velocity spiky; patterns match with velocity increasing as depth increased; Depth ranges from about 2 to 10 inches (during rain storms - 11/18/03) and velocity from about 2-1/2 fps to about 5 fps; erroneous velocity and depth data flagged; some velocity drops snapped to curve; fair to good hydraulics - relatively fast open channel flow; site responds to rain events (increased depth and velocity). Site surcharged for a short time on 11/18/03.
Lake Forest Park Pilot	Fair	Moderate	Poor depth data; velocity spiky; Depth ranges from about 1 to 7 inches (during surcharge and backwater conditions) and velocity from about 1 fps to about 5 fps; erroneous velocity and depth data flagged; pressure sensor depth used during surcharge and occasionally to replace poor ultrasonic depth data; poor to fair hydraulics - shallow and relatively fast open channel flow; site responds to rain events (increased depth and velocity); Site surcharged on 11/18/03 and 1/29/04; Backwater conditions observed 1/27/03 to 2/19/04 - field observation indicated that debris in the pipe could have created the observed backwater condition in the pipe by partially blocking the pipe and increasing the depth and reducing the velocity of the flow.
Mercer Control	Good	Minimal	Good depth and velocity data; Depth ranges from 1/2 to about 2-1/2 inches and velocity from about 2 fps to about 7 fps; erroneous velocity and depth data edited (minimal data editing); good hydraulics - shallow and fast flow; site responds to rain events, but didn't surcharge.

**Table D - 5.3 Post-rehabilitation monitoring period final data review summary and comments on data quality and data gaps**

Site Name	Data Quality*	Data loss**	Data review
Mercer Mini	Good	Minimal	Good depth and velocity data; Depth ranges from about 1 to 2-1/2 inches, but spikes to full pipe during rain storms; This site exhibits backwater conditions even at lower depths of flow ( 3.5 to 4 inches) and overflows to the overflow pipe ( @ 17.5 inches); such depth spikes have been edited; erroneous velocity and depth data flagged; pressure sensor depth used during surcharge; fair to good hydraulics - shallow and relatively fast (velocity 1 to 6 fps) open channel flow; site responds to rain events (increased depth and velocity); Site surcharged on 11/18/03, 11/19/03, 1/7/04, and 1/29/04.
Mercer Pilot	Fair to Good	Moderate	Good depth and velocity data; Depth ranges from about 1 to about 3-1/2 inches and velocity from about 1/2 fps to about 3 fps; erroneous velocity and depth data edited; velocity values that drop to zero during early morning hours are snapped to curve (minimal data editing); good hydraulics - relatively shallow and slow flow; site responds to rain events, but didn't surcharge.
North Shore Control	Fair to Good	Minimal	Good depth and velocity data; Depth ranges from about 1 to 6-1/2 inches; velocity ranges 1/2 to 2-1/2 fps; erroneous velocity and depth data flagged; some velocity data snapped to curve; fair to good hydraulics - moderately deep and relatively slow open channel flow; site responds to rain events (increased depth and velocity) , but no surcharge observed.
North Shore Pilot	Fair	Minimal	Good depth and poor velocity data; Depth ranges from about 1 to 3-1/2 inches; velocity ranges 1/2 to 2 fps; erroneous velocity and depth data flagged; some velocity data snapped to curve; poor to fair hydraulics - shallow and slow open channel flow; site responds to rain events (increased depth and velocity) , but no surcharge observed.
Redmond Control	Fair	Minimal	Good depth and spiky velocity data; Depth ranges from about 1 to 3 inches and goes to full pipe and surcharged during some spiky events; velocity ranges from less than 1 fps to about 2-1/2 fps; spiky velocity and some zero values snapped to curve and erroneous velocity and depth data edited; fair to good hydraulics - relatively shallow and slow flow slight response to rain events (increased depth and velocity).
Redmond Mini	Fair to Good	Minimal	Good depth and velocity data; Depth ranges from about 2 1/2 to 7 1/2 inches; velocity ranges 1/2 to 3 fps; early morning spikes (up to 25 inches max on 11/22/03) observed on 11/16, 11/18, 11/20, 11/22, 11/24, 11/26, 12/3, 12/12, 12/16, 12/17, 12/18, 12/19, and 12/23/03 and 1/21/04; erroneous velocity and depth data flagged; fair to good hydraulics moderately deep and slow open channel flow; site responds to rain events (increased depth and velocity) , but no surcharge due to rain observed; slight pattern shifts observed - site became deeper and faster starting 11/18/03 and returned to relatively shallower and slower around 12/20/03.
Redmond Pilot	Fair to Good	Minimal	Good depth and velocity data; Depth ranges from about 2 to 4 inches mostly and goes to full pipe and surcharged during some spiky events; velocity ranges from less than 1 fps to about 1-1/2 fps; spiky velocity and some zero values snapped to curve and erroneous velocity and depth data edited; fair to good hydraulics - relatively shallow and slow flow slight response to rain events (increased depth and velocity). Two patterns are apparent - site became deeper and slower after 2/20/04.
Ronald Control	Fair to Good	Minimal	Good depth and velocity data; Depth ranges from about 1/2 to 3-1/2 inches; velocity ranges 1/2 to 6 fps; erroneous velocity and depth data flagged; fair to good hydraulics - shallow and fast open channel flow; site responds to rain events (increased depth and velocity) , but no surcharge due to rain observed; Ultrasonic sensor was swapped on 1/14/04; The electronic offset was not adjust properly when swapping the sensor and the depth is adjusted by 1/2 inch (after 1/14/04) to reflect the change due to the improper electronic offset adjustment; field verifications on 1/14/04 indicate that the meter was off by about 0.5 inches

**Table D - 5.3 Post-rehabilitation monitoring period final data review summary and comments on data quality and data gaps**

Site Name	<a href="#">Data Quality*</a>	<a href="#">Data loss**</a>	Data review
Ronald Pilot	Poor to Fair	Significant	The ADS meter produced poor depth and spiky velocity - slight increase in depth was causing the flow to spray off of the sensor/ring assembly and splash on to the ultrasonic sensor (mounted at the crown of the pipe) giving erroneous depth data; Due to unreliable depth data during slightly elevated depths of flow, the ADS meter was replaced with a Flo-Dar unit. The Flo-Dar unit produced good depth and velocity data; Based on field verifications and consistency with the Flo-Dar unit, data from the ADS meter was adjusted by -0.13 inches. Depth ranges from about 1 to 3 inches; velocity ranges 1 to 6 fps; erroneous velocity and depth data flagged; poor to fair hydraulics - shallow and fast open channel flow; site responds to rain events (increased depth and velocity) , but no surcharge due to rain observed; two patterns observed - site got deeper and faster after the 11/18 - 11/19/03 storm
Skyway Control	Good	Minimal	Good depth and velocity data; Depth ranges from 1/2 to about 6 inches and velocity from about 1-1/2 fps to about 5 fps (during rain events); few erroneous velocity data edited (minimal data editing); good hydraulics - shallow (mostly < 2 inches) and slow (except during rain events) flow; site responds to rain events, but didn't surcharge. Velocity multiplier changed.
Skyway Pilot	Fair to Good	Minimal	Good depth and velocity data; Depth less than 2 inches and velocity ranges from about 3 to about 6 fps ( and increased to about 10 fps during rain events); Based on field verifications, the depth data was adjusted by 0.17 inches (level cal =0.17 on 1/13/04 verification). During install (10/9/03) it was noted that the incoming pipe (to the manhole) was offset. The field crew realigned the sensor on 11/4 to compensate for the pipe offset (Earth Tech visited the site on 11/7 to check the meter placement and the pipe offset). The depth data from 10/9 to 11/5/03 was reconstructed based on the data after realignment. erroneous velocity and depth data edited; good hydraulics - shallow (< 2 inches) and fast flow; site responds to rain events, but didn't surcharge.
Val Vue Control	Fair to Good	Minimal	Good depth and velocity data; patterns match with velocity increasing as depth increased; Depth ranges from about 1/2 inches to 2 inches and velocity from 3 fps to about 14 fps; some velocity drops snapped to curve and erroneous velocity and depth data flagged; fair to good hydraulics - shallow and fast open channel flow; site responds to rain events (increased depth and velocity) , but no surcharge due to rain observed; Very difficult site to confirm velocity (flow too fast)
Val Vue Pilot	Fair to Good	Minimal	Good depth and velocity data; patterns match with velocity increasing as depth increased; Depth ranges from about 1/2 inches to 4.5 inches and velocity from 1/2 fps to about 4.5 fps; some velocity drops snapped to curve and erroneous velocity and depth data flagged; fair to good hydraulics - shallow and moderately fast pump station influenced flow; site responds to rain events (increased depth and velocity) , but no surcharge due to rain observed; There is a Dosing Station upstream of this site. The Dosing Station consists of a rock catcher structure and a wet well dry well area. The Station feeds a double siphon dosing it to as a means to keep the siphons clean. The wet well is 8' in diameter and flushes 4' every time it flushes. The station has a 50.3 cubic feet or 377 gallons per/flush capacity.

\*, \*\* = qualitative ratings set by King County- click on links for details; \*\* = Data gap periods are listed in Appendix D Table D-2.2